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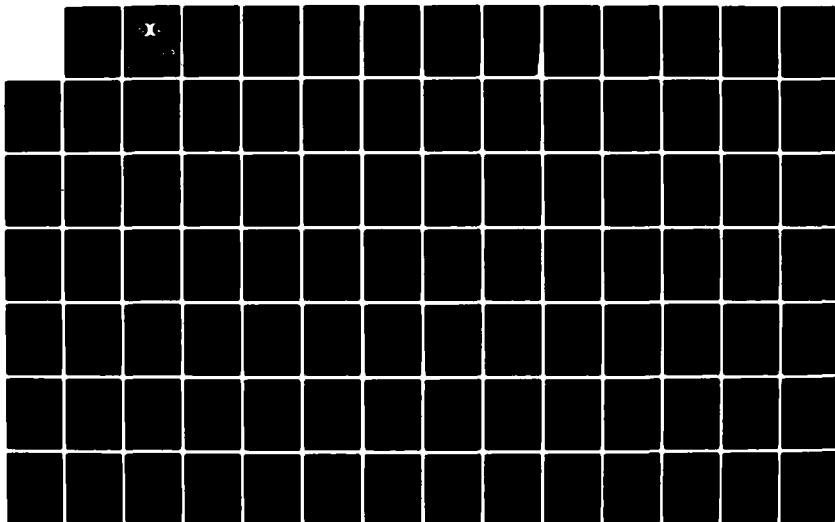
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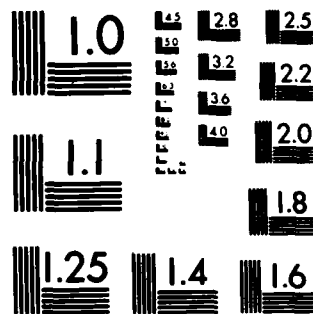
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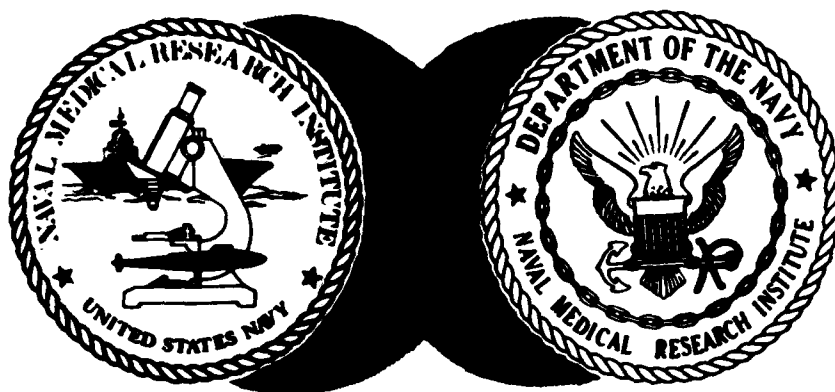
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NAVAL MEDICAL RESEARCH INSTITUTE

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DATA ACQUISITION AND ANALYSIS
SOFTWARE FOR THERMAL
STRESS STUDIES

R.P. Layton

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I. INTRODUCTION

A system to monitor heat flux and temperature at individual body sites using commercial heat flow transducers and thermistors has been developed at this facility. Details of the amplifier and multiplexer hardware are reported elsewhere (1). Since as many as 32 individual transducer signals (most of them multiplexed on two lines) can be outputted by this system each minute, an accurate and reliable data de-multiplexing and recording technique is a necessity. These functions have been automated with a Hewlett-Packard 9825 desktop computer and associated peripherals. The program that controls the digital data acquisition, "FLUX15," is described in the next section. The raw data recorded consist of the voltage outputs of the amplifier circuits for each transducer. These signals are of little value until they have been scaled into physical units. This function is provided by the program "HEAT15." Analysis of the data is aided by two additional software routines, "PLT15" and "AVG15." The former generates a plot of the output of each sensor as a function of time, while the latter computes the mean value of each transducer signal over a period of time chosen by the operator. Several less frequently used programs which complete the software package for this system are also described.

II. PROGRAM "FLUX15"

A. Introduction

Program "FLUX15" controls the acquisition and storage of data from the system designed to monitor cutaneous heat flux and temperature at individual body sites by means of an array of transducers. It accepts two lines of multiplexed information (heat flux and temperature) and 12 dedicated lines. With the current hardware, the program can accept up to 10 multiplexed heat flow transducers, 12 multiplexed temperature probes, and up to five combination heat flux/temperature non-multiplexed transducers. In addition, there are dedicated inputs from the internal clock of the electronics system and from the programmable voltage source used for calibration.

The program is written for the Hewlett-Packard 9825 computer which uses a software controlled scanner and digital voltmeter combination to select the data lines. Appendix 1b identifies which signal line is connected to each scanner input for proper operation. To stay in synchronization with the multiplexed signals, the program must be able to identify changes in levels of the system clock as well as the occurrence of a synchronization voltage level at the sixteenth multiplexed position. These voltages are defined in lines 42-43 of the program.

"FLUX15" contains a routine that stores information in a calibration file to allow the analysis program to calculate the gain and offset of each circuit. Thus it is not necessary for the operator to make zero and full-scale adjustments to the circuits themselves.

Once the data collection section of the program is running, the system is completely automatic and requires no further operator assistance until the experiment is finished. During a nominal one-minute cycle, each multiplexed sensor is read many times during a three-second period; the

individual readings are averaged to obtain a single value. Each of the auxiliary sensors is similarly measured over a two-second interval. At the end of each cycle the mean output values of all the sensors are stored in the data file on the flexible disk. When the user is ready to terminate the data acquisition routine, he uses the live keyboard to enter the value 1 into the variable V; this causes the program to stop at the end of the current cycle.

Since the calibration procedure is critical to the validity of the experimental data, it is important that this procedure be performed carefully and accurately. The calibration constants of the heat flux transducers are determined using an instrument (Dynateck R/D Co., model Rapid-k) that can maintain a known, fixed value of heat flux through the disks. This process is time-consuming and cannot be done before each experiment. Fortunately, experience at NMRI and elsewhere has shown that the values are stable (2). For the pre-experiment calibration a variable voltage source is connected to the inputs of the system which normally would receive the output signals of the heat flux sensors. The voltage source is set to 0 mV for the low level calibration and to 5 mV for the full-scale input. These simulated signals allow the electronic system to be checked and the gain and offset of the individual circuits to be determined.

The temperature probes are calibrated as integral parts of the system before each experiment. They are immersed in a water and ice slush and left there for 10 minutes until the temperature of the mixture has equilibrated. The temperature, as measured by a digital thermometer, is hand entered on the computer and the output of each temperature circuit is then measured automatically. Similarly, the full-scale temperature signals are determined by putting the probes in a 40°C stirred water bath.

The values obtained during calibration are printed for inspection by the user. The heat flux circuits have low offset and a nominal gain of 500; thus, the low level calibration output should be ~ 0.005 V and the high-level value should equal ~ 2.5 V. For temperature, the nominal scaling is $100 \text{ mV}/^{\circ}\text{C}$. The low output should read ~ 0.1 V and the high output ~ 4.0 V.

A program listing, variable allocations, flow charts, and required equipment are given in Appendix 1.

B. User Instructions

1. Insert: program disk into drive
Type: drive 0,8
Press: EXECUTE
2. Type: get "FLUX15"
Press: EXECUTE
When end of line symbol (↵) is displayed
Press: RUN
3. When "PRINTER SELECT CODE = ?" is displayed;
 - a. Type: number
 - b. Press: CONTINUE
4. When "REMOVE PROGRAM FLEXIBLE DISK!" is displayed;
 - a. Remove disk
 - b. Press: CONTINUE
5. When "INSERT DATA FLEXIBLE DISK!" is displayed;
 - a. Insert disk on which data is to be recorded
 - b. Press: CONTINUE
6. When "Enter # of HFS multiplexed" is displayed;
 - a. Type: L, where $L \leq 15$ is the number of heat flow transducers (normally $L = 10$)
 - b. Press: CONTINUE
7. When "Enter # of TMP multiplexed" is displayed;
 - a. Type: H, where $L \leq H \leq 15$ is the number of temperature sensors (normally $H = 12$ since rectal and ambient temperatures are read in addition to the 10 temperatures associated with each heat flow disk)
 - b. Press: CONTINUE
8. When "Enter # of Auxiliary sensors" is displayed;
 - a. Type: A, where $1 \leq A \leq 5$ (note that $A + H$ must be ≤ 17)
 - b. Press: CONTINUE
9. When "Do you want to calibrate?" is displayed;
 - a. If yes,
 - 1) Press: YES (special function key f_0)
 - 2) Go to step 10
 - b. If no,
 - 1) Press: No (special function key f_6)
 - 2) Go to step 30
10. When "Enter 6 character cal. file name" is displayed;
 - a. Type: name (must contain maximum of six characters; no spaces are allowed within name)
 - b. Press: CONTINUE

11. When "Enter heading for cal. file" is displayed;
 - a. Type: heading, which may contain a maximum of 80 characters and spaces
 - b. Press: CONTINUE
12. When "Calibrate heat flux sensors" is displayed;
 - a. Check that all heat flux inputs (multiplexed and auxiliary) are connected to output of calibration voltage source.
 - b. Press: CONTINUE
13. When "Cal HFS, LOW voltage (0 mv)" is displayed;
 - a. Check that voltage source is set to 0 output
 - b. Press: CONTINUE
14. When "Press CONT to read input volts" is displayed;
 - a. Check voltage being read on computer system digital voltmeter (DVM). If reading is ≈ 0.050 mV proceed; if reading is too high, remedy problem before continuing.
 - b. Press: CONTINUE
 - 1) "READING CALIBRATION VOLTAGE" is displayed
 - 2) Computer reads input voltage
 - 3) Value is printed
15. When "Press CONTINUE to take reading" is displayed;
 - a. Set HFS controller to "SELECT" channel 15
 - b. Press: CONTINUE
 - c. "Waiting for sync" is displayed
 - d. Set HFS controller to "SCAN"; wait ≈ 4 sec
 - e. "Calibration data is being read" is displayed for ≈ 1 min
 - f. Outputs in volts of HFS circuits are printed
16. When "Repeat Calibration?" is displayed;
 - a. If calibration results are satisfactory (output ≈ 0.005 V),
 - 1) Press: NO
 - 2) Go to step 17
 - b. If results must be repeated,
 - 1) Press: YES
 - 2) Go to step 13
17. When "Cal HFS, HIGH voltage (5mV)" is displayed;
 - a. Set voltage source output to $\approx + 5$ mV
 - b. Press: CONTINUE
18. "When Press CONT to read input volts" is displayed;
 - a. Check voltage being read on DVM. If it is ≈ 5 mV, proceed; if not, remedy problem before continuing.
 - b. Press: CONTINUE
 - 1) "READING CALIBRATION VOLTAGE" is displayed;
 - 2) Computer reads voltage
 - 3) Value is printed
19. When "Press CONTINUE to take reading" is displayed;
 - a. Set HFS controller to "SELECT" channel 15
 - b. Press: CONTINUE

- c. "Waiting for sync" is displayed
 - d. Set HFS controller to "SCAN"; wait ~4 sec
 - e. "Calibration data is being read" is displayed for ~1 min
 - f. Outputs in volts of HFS circuits are printed
20. When "Repeat Calibration?" is displayed;
- a. If calibration results are satisfactory (output ~2.5 V),
 - 1) Press: NO
 - 2) Go to step 21
 - b. If results must be repeated,
 - 1) Press: YES
 - 2) Go to step 17
21. When "CALIBRATE TEMPERATURE" is displayed;
- a. Check that all temperature sensors are totally immersed in ice/water slush and have had sufficient time (at least 10 min) to equilibrate with bath temperatures.
 - b. Check that all sensors are properly connected to the electronics of the system.
 - c. Press: CONTINUE
22. When "Low T in degrees C = ?" is displayed;
- a. Read temperature of ice bath on digital thermometer (Note: Check zero of thermometer)
 - b. Type: number for temperature in °C
 - c. Press: CONTINUE
 - d. Value is printed
23. When "Press CONTINUE to take reading" is displayed;
- a. Set HFS controller to "SELECT" channel 15
 - b. Press: CONTINUE
 - c. "Waiting for sync" is displayed
 - d. Set HFS controller to "SCAN"; wait ~4 sec
 - e. "Calibration data is being read" is displayed
 - f. Outputs in volts of temperature circuits are printed (should be ~0.1 V)
24. When "Repeat Calibration?" is displayed;
- a. If yes,
 - 1) Press: YES
 - 2) Go to step 22
 - b. If no,
 - 1) Press: NO
 - 2) Go to step 25
25. When "High T in degrees C = ?" is displayed;
- a. Remove sensors from ice bath and place in nominal 40°C bath
 - b. Wait several minutes for equilibration
 - c. Read bath temperature on digital thermometer
 - d. Type: number for temperature in °C
 - e. Press: CONTINUE
 - f. Value is printed
26. When "Press CONTINUE to take reading" is displayed;
- a. Set HFS controller to "SELECT" channel 15

- b. Press: CONTINUE
 - c. "Waiting for sync" is displayed
 - d. Set HFS controller to "SCAN"; wait ~4 sec
 - e. "Calibration data is being read" is displayed
 - f. Outputs in volts of temperature circuits are printed (values should be ~4.0 V)
27. When "Repeat Calibration?" is displayed;
- a. If no,
 - 1) Press: NO
 - 2) Go to step 28
 - b. If yes,
 - 1) Press: YES
 - 2) Go to step 25
28. [Calibration data are recorded on flexible disk.]
29. When "Calibration Completed" is displayed;
Press: CONTINUE
30. When "Enter 6 character data file name" is displayed;
- a. Type: name (must contain a maximum of six characters; no spaces are allowed within name)
 - b. Press: CONTINUE
31. When "Number of data records = ? (app. 1.2/min)" is displayed;
- a. Type: n, where $n > 1.2T$ and T is the maximum time in minutes for which data collection is to continue
 - b. Press: CONTINUE
32. If program stops and computer displays "error D8," flexible disk has insufficient room to store data file
- a. Remove disk
 - b. Insert new disk
 - c. Type: cont 54
 - d. Press: EXECUTE
 - e. Go to step 30
33. When "Enter first line of heading" is displayed;
- a. Type: up to 80-character line
 - b. Press: CONTINUE
34. When "Enter second line of heading" is displayed;
- a. Type: up to 80-character line or leave blank
 - b. Press: CONTINUE
35. When "Enter third line of heading" is displayed;
- a. Type: up to 80-character line or leave blank
 - b. Press: CONTINUE
36. When "Press Continue to Start Data" is displayed;
- a. Set HFS controller to "SELECT" channel 15
 - b. Press: CONTINUE when you are nearly ready to start data collection
 - c. "Waiting for sync signal" is displayed

- d. When ready to start data acquisition, set HFS controller to "SCAN";
wait ~4 sec
 - e. "In sync" is displayed (Note: Internal elapsed time clock of
computer starts at this time.)
37. [After ~1 min, the output signals of each transducer that were stored in
memory are recorded on the disk. The current rectal temperature and
elapsed time are displayed. This cycle is repeated once per minute
during the experiment with no further operator input.]
38. When the experiment is to be terminated;
- a. Type: 1 → V
 - b. Press: EXECUTE
 - c. The program will complete the current data collection cycle and then
display "Data Collection Ended"
39. "Press continue to duplicate data" will be automatically displayed 10 sec
later.
- a. If you wish to duplicate data using the HP 9885 single flexible disk
drive and tape cassette, go to step 40.
 - b. If you wish to duplicate data using the HP 9895 double flexible disk
drive
 - 1) Remove disk
 - 2) See instructions for duplication following this program.
40. Press: CONTINUE
41. When "INSERT TAPE FOR DATA DUMP" is displayed;
- a. Put tab on cassette in "RECORD" position
 - b. Insert tape in computer
 - c. Press: CONTINUE
 - d. "DATA IS BEING RECORDED ON TAPE" is displayed
42. When "REMOVE ORIGINAL DISK" is displayed;
- a. Remove disk
 - b. Press: CONTINUE
43. When "INSERT DISK FOR DUPLICATE DATA" is displayed;
- a. Insert disk
 - b. Press: CONTINUE
 - c. "DATA BEING RECORDED ON DISK" is displayed
44. When "DATA DUPLICATION COMPLETED" is displayed;
- a. Remove tape
 - b. Remove disk
 - c. Program is completed

C. Instructions for Duplicating Data on Dual Disk Drive

1. Insert: double-sided disk onto which data is to be copied into drive 0.
2. Insert: single-sided disk which contains original data into drive 1.
3. Type: copy "NAME", 1, 707, "NAME", 0, 707
(where NAME is the calibration file to be copied)
Press: EXECUTE
4. Wait for end of line symbol (↵) to be displayed
5. Type: copy "NAME", 1, 707, "NAME", 0, 707 (where NAME is the data file to be copied)
Press: EXECUTE
6. When end of line symbol (↵) appears the duplication is completed.

III. Program "HEAT15"

A. Introduction

The data stored by program "FLUX15" consist of the actual voltage signals of the sensors. For this information to be useful it must be properly scaled into physical units. Program "HEAT15" performs this function. It uses values stored in a calibration file, a data file, and in file "ARRAY15" to produce a new file containing the scaled data.

The program first calculates a gain for each sensor circuit as follows:

$$G_H = 1000(H_1 - H_0)/(V_1 - V_0)$$

$$G_T = (T_1 - T_0)/(t_1 - t_0)$$

where:

G_H = gain of heat flux circuit (dimensionless)

H_1 = heat flux high calibration voltage output (V)

H_0 = heat flux low calibration voltage output (V)

V_1 = heat flux high calibration voltage input (mV)

V_0 = heat flux low calibration voltage input (mV)

G_T = gain of temperature circuit (volts/ $^{\circ}$ C)

T_1 = temperature high calibration voltage output (V)

T_0 = temperature low calibration voltage output (V)

t_1 = actual high temperature calibration value ($^{\circ}$ C)

t_0 = actual low temperature calibration value ($^{\circ}$ C).

The offset (output signal with a zero input) is then determined for each circuit by:

$$D_H = H_0 - (G_H)(V_0/1000)$$

$$D_T = T_0 - (G_T)(t_0)$$

where:

D_H = offset of heat flux circuit (V)

D_T = offset of temperature circuit (V)

The raw data are then scaled using the equations:

$$Z_H = 1000 [(X_H - D_H)/G_H](F_H)$$

$$Z_T = (X_T - D_T)/G_T$$

where:

Z_H = scaled heat flux (W/M^2)

X_H = unscaled heat flux transducer output (V)

F_H = calibration constant for heat flux transducer (W/M^2-mV)
(from "ARRAY15")

Z_T = scaled temperature ($^{\circ}C$)

X_T = unscaled temperature transducer output (V)

At this point, a regional heat flux and temperature have been computed for each sensor. To obtain a rate of heat loss, both the total body surface area and the fraction represented by each transducer must be known. The area weighting factors selected by the user are contained in "ARRAY15" (3, 4). The total area is calculated with the equation of Dubois and Dubois (5):

$$S = (A^{0.725})(B^{0.425})(71.84)(10^{-4})$$

where:

S = Surface area in M^2

A = height of subject in cm

B = weight of subject in Kg

The scaled data are recorded on the flexible disk in serial form according to the format:

C\$, D\$, E\$, B\$, F\$, N[*], r8,

U, E, F[*], M[*], P[*]

where the variables are identified in Appendix 2. The first line occurs once in each data file; the second, with different values stored in the variables, is repeated for each nominal one-minute data cycle of the system controller.

User instructions are given in the next section. Program listing, variable allocations, and equipment list are provided in Appendix 2.

B. User Instructions

1. Insert: program disk into drive 0
Type: drive 0, 707
Press: EXECUTE
2. Type: get "HEAT15"
Press: EXECUTE
When end of line mark (␣) is displayed
Press: RUN
3. When "Printer Select Code?" is displayed;
 - a. Type: number
 - b. Press: CONTINUE
4. When "INSERT DATA DISK in drive 0" is displayed;
 - a. Remove program disk
 - b. Insert double-sided disk containing data files produced by "FLUX15" into drive 0
 - c. Press: CONTINUE
5. When "INSERT NEW DATA DISK in drive 1" is displayed;
 - a. Insert disk in drive 1 on which new data file containing scaled values is to be recorded. (Note: This disk must already have recorded on it the proper "ARAY15" file created by program "SNSR15")
 - b. Press: CONTINUE
6. When "Name of Calibration file?" is displayed;
 - a. Type: name of original calibration file
 - b. Press: CONTINUE
7. When "Name of Data file wanted?" is displayed;
 - a. Type: name of original data file
 - b. Press: CONTINUE
8. When "Name for new analyzed data file" is displayed;
 - a. Type: name of data file in which new scaled data is to be stored
 - b. Press: CONTINUE
9. When "# records in original data file?" is displayed;
 - a. Type: number (Note: This number can be found by executing the catalogue command for drive 0)
 - b. Press: CONTINUE
10. When "Do you want printout?" is displayed;
 - a. If no,
 - 1) Press: NO
 - 2) Go to step 18
 - b. If yes,
 - 1) Press: YES
 - 2) Sensor information stored in "ARAY15" is printed

- c. When "Do you want to change ARAY15?" is displayed;
 - 1) If no,
 - a) Press: NO
 - b) Go to step 18
 - 2) If yes,
 - a) Press: YES
 - b) Go to step 11
11. When "Number of MPX HFS = ?" is displayed;
 - a. Type: number of multiplexed heat flux sensors
 - b. Press: CONTINUE (Note: In this and the following steps 12-15, if the information requested in a particular line need not be changed from that already stored in "ARAY15," simply press CONTINUE. The originally entered number will remain unchanged.)
12. When "Number of T sensors = ?" is displayed;
 - a. Type: number of multiplexed temperature sensors
 - b. Press: CONTINUE
13. When "Number of AUX sensors = ?" is displayed;
 - a. Type: number
 - b. Press: CONTINUE
14. When "Sensor # <I>" is displayed (where $1 \leq I \leq 10$);
 - a. Press: CONTINUE
 - b. When "Serial # = ?" is displayed;
 - 1) To enter a new number for multiplexed # I,
 - a) Type: number
 - b) Press: CONTINUE
 - 2) To leave number unchanged
Press: CONTINUE
 - c. When "Cal const = ?" is displayed;
 - 1) To enter a new heat flux calibration constant (W/M^2-mV) for sensor # I,
 - a) Type: number
 - b) Press: CONTINUE
 - 2) To leave unchanged,
Press: CONTINUE
 - d. When "Weighting factor = ?" is displayed;
 - 1) To enter a new fractional surface area factor (use decimal form) for sensor # I,
 - a) Type: number
 - b) Press: CONTINUE
 - 2) To leave unchanged
Press: CONTINUE
 - e. Does $I = 10$?
 - 1) If yes, go to step 15
 - 2) If no, I is incremented by 1; go to step 14
15. When "AUX # <I>" is displayed (where $1 \leq I \leq 5$);
 - a. Press: CONTINUE
 - b. When "Serial # = ?" is displayed;

- 1) To enter a new number for auxiliary sensor # I,
 - a) Type: number
 - b) Press: CONTINUE
 - 2) To leave unchanged
Press: CONTINUE
 - c. When "Cal const = ?" is displayed;
 - 1) To enter new heat flux calibration constant (W/M^2-mV) for auxiliary sensor # I,
 - a) Type: number
 - b) Press: CONTINUE
 - 2) To leave unchanged
Press: CONTINUE
 - d. When "Weighting factor = ?" is displayed;
 - 1) To enter new number for auxiliary sensor # I,
 - a) Type: number (decimal)
 - b) Press: CONTINUE
 - 2) To leave unchanged
Press: CONTINUE
 - e. Does I > 5?
 - 1) If yes, go to step 16
 - 2) If no, I is incremented by 1; go to step 15
16. [New values are printed and then stored on disk in drive 1 to form new "ARRAY15" file.]
17. When "Modify ARRAY15 again?" is displayed;
- a. If yes,
 - 1) Press: YES
 - 2) Go to step 11
 - b. If no,
 - 1) Press: NO
 - 2) Go to step 18
18. When "Height of subject (inches) = ?" is displayed;
- a. Type: number in inches
 - b. Press: CONTINUE
19. When "Weight of subject (pounds) = ?" is displayed;
- a. Type: number in pounds
 - b. Press: CONTINUE
20. If you answered "NO" to step 10, go to step 22; otherwise continue with step 20;
- a. Parameters used to compute properly scaled values are printed
 - b. When "Make necessary changes, then continue" is displayed;
 - 1) If no changes are to be made for the parameters just printed
 - a) Press: CONTINUE
 - b) Go to step 21
 - 2) If some parameters are to be changed
 - a) Use the live keyboard to assign new values (Note: This is done by identifying the variables to be changed with the variable assignment listings and then assigning the number wanted to each. For example, if the operator wants to change the gain of multiplexed temperature circuit # 11 to 0.100, he

finds the appropriate variable to be S[2, 11]. He then proceeds with:

1) Type: $0.1 \rightarrow S[2, 11]$

2) Press: EXECUTE

The process is repeated until all variables selected by the user have been modified.)

b) When finished

Press: CONTINUE

21. When "Did you make any changes?" is displayed;
 - a. If no,
 - 1) Press: NO
 - 2) Go to step 22
 - b. If yes,
 - 1) Press: YES
 - 2) New parameters are printed
 - 3) Go to step 20.b.
22. When "Enter heading (3 lines available)" is displayed;
 - a. Type: up to 80 character heading line
 - b. Press: CONTINUE
 - c. Go to step 22 until three lines have been entered
23. ["DATA ANALYSIS RUNNING" is displayed.] (Process may take several minutes depending on size of data file.)
24. When "Print total heat loss?" is displayed;
 - a. If yes,
 - 1) Press: YES
 - 2) Total regional and whole body heat losses from beginning to end of experiment are printed.
 - 3) Go to step 25
 - b. If no,
 - 1) Press: NO
 - 2) Go to step 25
25. When "ANALYSIS FINISHED; another run?" is displayed;
 - a. If another file is to be analyzed,
 - 1) Press: YES
 - 2) Go to step 4
 - b. If no,
 - 1) Press: NO
 - 2) "PROGRAM FINISHED" is displayed

IV. PROGRAM "SNSR15"

A. Introduction

Information concerning the fractional surface area represented by individual sensors as well as their calibration constants is needed by program "HEAT15" to properly scale the raw data. These values are contained in a data file called "ARRAY15." While program "HEAT15" enables the operator to make changes in "ARRAY15" it cannot create the original file. Program "SNSR15" can be used either to create a new "ARRAY15" file or to modify an existing one. An "ARRAY15" must exist on each flexible disk on which "HEAT15" is to record scaled data. A program listing appears in Appendix 3. The equipment requirements are the same as for "HEAT15."

B. User Instructions

1. Insert program disk into drive 0
Type: drive 0, 707
Press: EXECUTE
2. Type: get "SNSR15"
Press: EXECUTE
3. When end of line mark (␣) is displayed
Press: RUN
4. When "Remove Program Disk" is displayed;
 - a. Remove disk from drive 0
 - b. Press: CONTINUE
5. When "Insert Disk for ARAY15 file" is displayed;
 - a. Insert disk into drive 0
 - b. Press: CONTINUE
6. When "Printer Select Code = ?" is displayed;
 - a. Type: number
 - b. Press: CONTINUE
7. When "Create new ARAY15 file?" is displayed;
 - a. If previous "ARAY15" file exists,
 - 1) Press: NO
 - 2) Go to step 8
 - b. If no previous "ARAY15" file exists,
 - 1) Press: YES
 - 2) Go to step 10
8. [Current contents of "ARAY15" file are printed.]
9. When "Modify ARAY15 file?" is displayed;
 - a. If changes are to be made,
 - 1) Press: YES
 - 2) Go to step 10
 - b. If file is correct as it stands,
 - 1) Press: NO
 - 2) Program stops
10. When "Number of MPX HFS = ?" is displayed;
 - a. Type: N, where N is the number of multiplexed heat flux sensors
(Note: In steps 10-21, if the information requested in a particular line need not be changed from that already stored in "ARAY15," simply press CONTINUE. The originally entered number will remain unchanged.)
 - b. Press: CONTINUE
11. When "Number of MPX TMP sensors = ?" is displayed;
 - a. Type: N, where N is the number of multiplexed temperature sensors
 - b. Press: CONTINUE

12. When "Number of AUX sensors = ?" is displayed;
 - a. Type: N, where N is the number of auxiliary sensors
 - b. Press: CONTINUE
13. When "Sensor # <I>" is displayed,
Press: CONTINUE
14. When "Serial # = ?" is displayed;
 - a. Type: number for serial number of sensor # I
 - b. Press: CONTINUE
15. When "Cal const = ?" is displayed;
 - a. Type: number for heat flux calibration constant (W/M^2 -mV) for sensor # I
 - b. Press: CONTINUE
16. When "Weighting factor = ?" is displayed;
 - a. Type: number for fractional surface area weighting factor (decimal) for sensor # I
 - b. Press: CONTINUE
17. Is I < 10?
 - a. If yes,
 - 1) I is incremented by 1
 - 2) Go to step 13
 - b. If no, go to step 18
18. When "AUX # <I>" is displayed;
Press: CONTINUE
19. When "Serial # = ?" is displayed;
 - a. Type: number for auxiliary sensor # I
 - b. Press: CONTINUE
20. When "Cal const = ?" is displayed;
 - a. Type: number for heat flux calibration constant (W/M^2 -mV) for auxiliary sensor # I
 - b. Press: CONTINUE
21. When "Weighting factor = ?" is displayed;
 - a. Type: number for surface area weighting factor (decimal) for auxiliary sensor # I
 - b. Press: CONTINUE
22. Is I < 5?
 - a. If yes, I is incremented by 1, go to step 18
 - b. If no, go to step 23
23. [The contents of file "ARAY15" just entered are printed.]

24. When "Does previous ARAY15 file exist?" is displayed;
 - a. If file exists on the flexible disk,
Press: YES
 - b. If file does not already exist on the disk,
Press: NO
25. [New "ARAY15" file is stored on flexible disk.]
26. ["Program Finished" is displayed.]

V. PROGRAM "PLT15"

A. Introduction

It is often useful to plot data from the individual sensors in order to verify their proper functioning and to look for trends and other features of the data. Program "PLT15" performs this function for scaled data files created by "HEAT15" or "cmbDAT." The program allows the user to select whether he wants to inspect the output of a few sensors or wants all the data to be plotted automatically. Experience has shown that when a heat flux transducer malfunctions it usually outputs a constant, near-zero voltage. The temperature probes, however, often produce wildly varying signals when they become defective. To eliminate these distracting traces from the plots, the program allows individual temperature sensors to be deleted from the automatic cycle. It should be noted that due to restrictions on the memory capacity of the computer, only scaled data files with the number of records <375 can be plotted. This limit usually is not a problem since it represents an elapsed time of ~6 h.

The program listing, variable assignments, and equipment list are given in Appendix 4. Detailed user instructions for "PLT15" are given in the following section.

B. User Instructions

1. Insert program disk in drive 0
Type: get "PLT15"
Press: EXECUTE
2. When end of line mark (␣) is displayed
Press: RUN
3. When "Remove Program Disk" is displayed;
 - a. Remove disk
 - b. Press: CONTINUE
4. When "Insert Data Disk" is displayed;
 - a. Insert disk containing scaled data to be plotted in drive 0
 - b. Press: CONTINUE
5. When "Enter name of analyzed data file" is displayed;
 - a. Type: name
 - b. Press: CONTINUE
6. When "Plotter Select Code = ?" is displayed;
 - a. Type: select code of plotter to be used
 - b. Press: CONTINUE
 - c. Put paper on plotter and set points P1 and P2 as necessary
7. When "Number of Heat Flux sensors = ?" is displayed;
 - a. Type: total number (multiplexed and auxiliary) of flux sensors to be plotted (maximum of 15)
8. When "Max time to be searched = ?" is displayed;
 - a. Type: number (in minutes) [Program will find maximum and minimum values of heat flux and temperature; it will search from time zero to the end of data file or to time entered here, whichever is less.]
 - b. Press: CONTINUE
 - c. "SEARCHING FOR MAXIMUM VALUES" is displayed
 - d. Maximum and minimum values are printed
9. When "Plot heat flux data?" is displayed;
 - a. If yes,
 - 1) Press: YES (key f_0)
 - 2) Go to step 10
 - b. If no,
 - 1) Press: NO (key f_6)
 - 2) Go to step 22
10. When "Draw axes?" is displayed;
 - a. If you want axes drawn for heat flux plot,
Press: YES (x-axis is time in minutes, y-axis is heat flux in W/M^2)
 - b. If you want data plotted without axes being drawn
Press: NO

11. When "Maximum value of time = ?" is displayed;
 - a. Type: number for maximum value of time wanted on X-axis of plot
 - b. Press: CONTINUE
12. When "Maximum value of heat flux = ?" is displayed;
 - a. Type: number wanted for maximum value of heat flux (W/M^2) on Y-axis of plot
 - b. Press: CONTINUE
13. When "Minimum value of heat flux = ?" is displayed;
 - a. Type: number wanted for minimum value of heat flux (W/M^2) on Y-axis of plot
 - b. Press: CONTINUE
14. If you answered "NO" in step 10, go to step 17.
15. When "X-axis tic interval = ?" is displayed;
 - a. Type: number (in minutes) that represents the time between labelled tic marks on the X-axis
 - b. Press: CONTINUE
16. When "Y-axis tic interval = ?" is displayed;
 - a. Type: number (in W/M^2) that represents the interval between labelled tic marks on the Y-axis
 - b. Press: CONTINUE
 - c. Axes are drawn
17. When "Plot individual sensors?" is displayed;
 - a. If you want all sensors automatically plotted,
 - 1) Press: NO
 - 2) Go to step 18
 - b. If you want to select only certain sensors to be plotted,
 - 1) Press: YES
 - 2) Go to step 18
18. ["Heat Flux Data is being read" is displayed.]
19. Are individual sensors to be plotted?
 - a. If you answered "YES" in step 17, then "Sensor HF to be plotted?" is displayed;
 - 1) Type: number (auxiliary HFS # I is selected by entering # [I + 10])
 - 2) Press: CONTINUE
 - 3) Go to step 20 (To get out of loop, enter a number >15, then go to step 22)
 - b. If you answered "NO" in step 17, then all sensors will be plotted automatically. Go to step 20.
20. ["Plotting sensor # <n>" is displayed as the data are plotted.]
21. Are individual sensors being plotted?
 - a. If yes, return to step 19.a.

- b. If sensors are being plotted automatically
 - 1) If $n < \text{number entered in step 7}$,
 - a) n is incremented by 1
 - b) Go to step 20
 - 2) If $n = \text{number entered in step 7}$, go to step 22.
- 22. When "Plot individual TMP sensors?" is displayed;
 - a. If you want to plot only individually selected sensors
 - 1) Press: YES
 - 2) Go to step 25
 - b. If you want temperatures plotted automatically,
 - 1) Press: NO
 - 2) When "Do you want to delete some TMP?" is displayed;
 - a) If you want some temperature sensors deleted from the automatic plotting routine,
 - (1) Press: YES
 - (2) Go to step 23
 - b) If you want all sensors plotted,
 - (1) Press: NO
 - (2) Go to step 25
- 23. When "How many TMPs to be deleted?" is displayed;
 - a. Type: number
 - b. Press: CONTINUE
- 24. When "TMP sensor # to be deleted = ?" is displayed;
 - a. Type: number ($1 \leq n \leq 17$) of one of the sensors to be deleted (auxiliary # I is selected by # $[I + 12]$; rectal temperature is # 11; ambient temperature is # 12)
 - b. Press: CONTINUE
 - c. Return to step 24.a. until the number of sensors specified in step 23 have been selected
- 25. When "Prepare plotter for TEMP plot" is displayed;
 - a. Remove heat flux plot
 - b. Position paper for temperature plot
 - c. Press: CONTINUE
- 26. When "Draw axes?" is displayed;
 - a. If you want axes drawn for temperature plot
 - Press: YES (X-axis is time in minutes, Y-axis is temperature $^{\circ}\text{C}$)
 - b. If you want data plotted without axes being drawn
 - Press: NO
- 27. When "Maximum value of time = ?" is displayed;
 - a. Type: number wanted for maximum value of time on X-axis of plot
 - b. Press: CONTINUE
- 28. When "Maximum value of temperature = ?" is displayed;
 - a. Type: number wanted for maximum value of temperature ($^{\circ}\text{C}$) on Y-axis of plot
 - b. Press: CONTINUE

29. When "Minimum value of temperature =?" is displayed;
 - a. Type: number wanted for minimum value of temperature ($^{\circ}\text{C}$) on Y-axis of plot
 - b. Press: CONTINUE
30. If you answered "NO" in step 26, go to step 33.
31. When "X-axis tic interval = ?" is displayed;
 - a. Type: number (in minutes) that represents the time between labelled tic marks on X-axis
 - b. Press: CONTINUE
32. When "Y-axis tic interval = ?" is displayed;
 - a. Type: number ($^{\circ}\text{C}$) that represents the interval between labelled tic marks on the Y-axis
 - b. Press: CONTINUE
 - c. Axes are drawn
33. Are individual sensors to be plotted?
 - a. If you answered "YES" in step 22, then "TMP sensor to be plotted = ?" is displayed;
 - 1) Type: number (auxiliary # 1 is selected by entering # [1 + 12]; rectal temperature = 11; ambient temperature = 12)
 - 2) Press: CONTINUE
 - 3) Go to step 34 (To get out of the loop, enter a number >17, then go to step 36)
 - b. If you answered "NO" in step 22, then sensors will be plotted automatically, go to step 34
34. ["Plotting sensor # <n>" is displayed as the data are plotted.]
35. Are individual sensors being plotted?
 - a. If yes, return to step 33.a.
 - b. If sensors are being plotted automatically,
 - 1) If $(n-2) <$ number entered in step 7,
 - a) n is incremented by 1
 - b) Go to step 34
 - 2) If $(n-2) =$ number entered in step 7, Go to step 36
36. When "Another set of plots to be run?" is displayed;
 - a. If yes,
 - 1) Press: YES
 - 2) Go to step 5
 - b. If no,
 - 1) Press: NO
 - 2) "PLOTING ROUTINE FINISHED" is displayed

VI. Program "AVG15"

A. Introduction

Often when data are being analyzed, it is desirable to compare the steady-state values obtained under one set of experimental conditions with those found for different conditions. A more accurate comparison can be made if the heat flux and temperature results are averaged over a number of data collection cycles. Program "AVG15" performs this function.

Once the operator has entered the numbers of the first and last data records which specify a time interval, the program finds the arithmetic mean of the output of each sensor for the interval designated. The name of each body site monitored is stored in the data file "SITE" which can be created and/or modified using "AVG15." The output appears on the external printer. It consists of the mean values for each transducer of heat flux, skin temperature, differential temperature between skin and ambient, and convective heat flow coefficient.

The user instructions appear in the following section. Program listing and variable assignments are given in Appendix 5.

B. User Instructions

1. Insert program disk in drive 0
Type: get "AVG15"
Press: EXECUTE
2. When end of line mark (␣) is displayed
Press: RUN
3. When "Remove Program Disk" is displayed;
 - a. Remove disk
 - b. Press: CONTINUE
4. When "Insert Data Disk in drive 0" is displayed;
 - a. Insert disk
 - b. Press: CONTINUE
5. When "Printer Select Code = ?" is displayed;
 - a. Type: select code number
 - b. Press: CONTINUE
6. When "Enter name of analyzed data file" is displayed;
 - a. Type: name
 - b. Press: CONTINUE
7. When "Do you want max time search?" is displayed;
 - a. If yes,
 - 1) Press: YES (key f₀)
 - 2) Go to step 8
 - b. If no,
 - 1) Press: NO (key f₆)
 - 2) Go to step 10
8. ["Finding maximum time" is displayed.]
9. On internal printer is output:
 - a. "Max record # = <n>"
 - b. "Max time = <m>"
10. When "Create new SITE file?" is displayed;
 - a. If a "SITE" file has been previously stored on this disk,
 - 1) Press: NO
 - 2) Go to step 13
 - b. If a "SITE" file does not already exist on this disk,
 - 1) Press: YES
 - 2) Go to step 11
11. When "SENSOR # <I>" is displayed;
 - a. Press: CONTINUE
 - b. When "Body site name = ?" is displayed;
 - 1) Type: name (maximum of 10 characters)
 - 2) Press: CONTINUE

- c. Is $I < 15$?
 - 1) If yes,
 - a) I is incremented by 1
 - b) Go to step 11
 - 2) If no, go to step 12
- 12. When "Does Previous SITE file exist?" is displayed
Press: NO
- 13. When "Do you want SITE printed?" is displayed;
 - a. If yes,
 - 1) Press: YES
 - 2) Contents of file are printed on external printer
 - 3) Go to step 14
 - b. If no,
 - 1) Press: NO
 - 2) Go to step 14
- 14. When "Do you want to change SITE?" is displayed;
 - a. If no,
 - 1) Press: NO
 - 2) Go to step 17
 - b. If yes,
 - 1) Press: YES
 - 2) Go to step 15
- 15. When "Sensor # <I>" is displayed;
 - a. Press: CONTINUE
 - b. When "Body site name = ?" is displayed;
 - 1) If name is not to be changed,
 - a) Press: CONTINUE
 - b) Go to step c.
 - 2) If the name is to be changed,
 - a) Type: new name
 - b) Press: CONTINUE
 - c) Go to step c.
 - c. Is $I < 15$?
 - 1) If yes,
 - a) I is incremented by 1
 - b) Go to step 15
 - 2) If no, go to step 16
- 16. When "Does previous SITE file exist?" is displayed,
 - a. Press: YES
 - b. New "SITE" file is recorded
 - c. Go to step 13
- 17. When "# of first record wanted = ?" is displayed;
 - a. Type: number
 - b. Press: CONTINUE
- 18. When "# of last record wanted = ?" is displayed;
 - a. Type: number
 - b. Press: CONTINUE

19. ["Averaging Data" is displayed.]
(The time-averaged value for each heat flux and temperature sensor will be computed for the interval between the first and last data records chosen above.)
20. [Average values are printed on external printer using the contents of the "SITE" file to identify each sensor.]
21. When "Average another period?" is displayed;
 - a. If yes,
 - 1) Press: YES
 - 2) Go to step 17
 - b. If no,
 - 1) Press: NO
 - 2) Go to step 22
22. When "Analyze another data file?" is displayed;
 - a. If yes,
 - 1) Press: YES
 - 2) Go to step 6
 - b. If no,
 - 1) Press: NO
 - 2) Program ends

VII. UTILITY PROGRAMS

A. Introduction

The four programs described in this section are utility programs used to troubleshoot the system or to perform minor editing of the scaled data files. Program listings are given in Appendix 6.

Program "RCAL15" reads the information stored in a calibration file and prints the values on an external printer. Program "RDAT15" performs the same function for an original data file. Note that the numbers printed are the voltages actually measured by the DVM and are not scaled. Thus the operator has access to the raw data, which is often useful in tracking down problems in the system. The printout of "RCAL15" is sufficiently labelled so that there should be no confusion as to the information that is displayed. Note that both these programs assume the printer select code is 706. The format of the printout for "RDAT15" is the following:

heading of data file	
# temperatures multiplexed	# heat flux multiplexed
{ # of record	time of record (minutes)
10 values of multiplexed heat flux	
12 values of multiplexed temperature	
5 values of auxiliary heat flux	
5 values of auxiliary temperature	

The section in brackets is repeated for each data record in the data file.

Occasionally a data file is closed before an experiment is completed. This situation can arise for a number of reasons, such as reserving too few records on the disk to hold the data or a power outage that causes the computer to lose the program. In such cases, the program can be re-started and the ensuing data recorded in a new file. The fact that data from a given experiment are contained in more than one file can be inconvenient when the user desires a plot of the complete experiment or wants to run an analysis routine. Program "cmbDAT" combines two scaled data files (created by "HEAT15") into a single one. Drive 0 of the dual flexible disk drive must contain the disk with the files to be combined and drive 1 the disk on which the new file is to be recorded. To find the number of records required on the disk for each of the files, the operator can execute a catalogue command for drive 0. When the program has finished, the original files are left unaltered; the new combined file is recorded on the drive 1 disk under the name selected.

The program "negHFS" is helpful whenever heat flux transducers have been reverse-wired or applied to a subject with the wrong surface toward the skin. Since the voltage output of these sensors only changes sign when the direction of heat flow changes, the data collected can have the correct amplitude but the wrong algebraic sign. Any scaled data file produced by "HEAT15" can be corrected for this problem with program "negHFS."

The dual flexible disk drive (HP 9895) is needed; the disk containing the scaled data is placed in drive 0, while a "scratch" disk used for temporary storage is placed in drive 1. The operator selects which heat flux signals are to be reversed. When the program is finished, the original scaled data file has been replaced with the new file (with the appropriate reversed values) and the scratch disk is left with no new files recorded on it.

B. User Instructions for "RCAL15"

1. Insert program disk
Type: get "RCAL15"
Press: EXECUTE
2. When "end of line mark (␣) is displayed
Press: RUN
3. When "Remove Program Disk" is displayed;
 - a. Remove disk
 - b. Press: CONTINUE
4. When "Insert Data Disk" is displayed;
 - a. Insert disk
 - b. Press: CONTINUE
5. When "Enter name of file to be read" is displayed;
 - a. Type: name
 - b. Press: CONTINUE
 - c. Contents of file are printed
 - d. Program ends

(Note: Program assumes select code of external printer is 706.)

C. User Instructions for "RDAT15"

1. Insert program disk
Type: get "RDAT15"
Press: EXECUTE
2. When end of line mark (␣) is displayed
Press: RUN
3. When "Remove Program disk" is displayed;
 - a. Remove disk
 - b. Press: CONTINUE
4. When "Insert Data Disk" is displayed;
 - a. Insert disk
 - b. Press: CONTINUE
5. When "Enter name of file to be read" is displayed;
 - a. Type: name
 - b. Press: CONTINUE
6. When "Do you want temperature values?" is displayed;
 - a. If yes,
 - 1) Press: YES (key f₀)
 - 2) Go to step 7
 - b. If no,
 - 1) Press: NO (key f₆)
 - 2) Go to step 7
7. [Contents of file are printed.]
Program ends

D. User Instructions for "cmbDAT"

1. Insert: program disk into drive 0
Type: get "cmbDAT"
Press: EXECUTE
2. When end of line mark (↵) is displayed
Press: RUN
3. When "Remove Program Disk" is displayed;
 - a. Remove disk
 - b. Press: CONTINUE
4. When "Insert Data Disk in drive 0" is displayed;
 - a. Insert disk with data files to be combined
 - b. Press: CONTINUE
5. When "Insert new file disk in drive 1" is displayed;
 - a. Insert disk on which combined file is to be recorded
 - b. Press: CONTINUE
6. When "Name of first data file?" is displayed;
 - a. Type: name
 - b. Press: CONTINUE
7. When "Name of second data file?" is displayed;
 - a. Type: name
 - b. Press: CONTINUE
8. When "Name of combined data file?" is displayed;
 - a. Type: name
 - b. Press: CONTINUE
9. When "# of records for combined file?" is displayed;
 - a. Type: number (must be \geq sum of records for files 1 and 2)
 - b. Press: CONTINUE
10. When "New header for combined file = ?" is displayed;
 - a. Type: alphanumeric line up to 80 characters long
 - b. Press: CONTINUE
 - c. Return to step 10 until 3 lines have been entered
11. When "Elapsed minutes between files = ?" is displayed;
 - a. Type: time in minutes that elapsed between the moment data collection stopped for first file and restarted for second file.
 - b. Press: CONTINUE
12. ["Combining Data Files Now" is displayed.]
13. When "Finished" is displayed;
 - a. Program has ended
 - b. Remove disks

E. User Instructions for "negHFS"

1. Insert: program disk in drive 0
Type: get "negHFS"
Press: EXECUTE
2. When end of line mark (↵) is displayed
Press: RUN
3. When "Remove Program Disk" is displayed;
 - a. Remove disk
 - b. Press: CONTINUE
4. When "Insert Data Disk in drive 0" is displayed;
 - a. Insert disk on which data file is recorded
 - b. Press: CONTINUE
5. When "Insert Scratch Disk in drive 1" is displayed;
 - a. Insert disk to be used as temporary storage disk during running of program
 - b. Press: CONTINUE
6. When "Name of Data file?" is displayed;
 - a. Type: name
 - b. Press: CONTINUE
7. [Header of file is printed.]
8. When "Number of records in data file?" is displayed;
 - a. Type: number
 - b. Press: CONTINUE
9. When "How many HFS to be reversed?" is displayed;
 - a. Type: number
 - b. Press: CONTINUE
10. When "HF sensor # to be reversed = ?" is displayed;
 - a. Type: number (from 1 to 15) of one heat flux sensor whose signal is to be inverted. (Note: auxiliary sensor # 1 is assigned the number [10 + I] in this instance.)
11. ["Program is Running Now" is displayed.]
12. When "Finished" is displayed, remove disks.

The values obtained during calibration are printed for inspection by the user. The heat flux circuits have low offset and a nominal gain of 500; thus, the low level calibration output should be <0.05 V and the high-level value should equal <2.5 V. For temperature, the nominal scaling is $100 \text{ mV}/^{\circ}\text{C}$. The low output should read ~ 0.1 V and the high output ~ 4.0 V.

A program listing, variable allocations, flow charts, and required equipment are given in Appendix 1.

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"FLUX15"

EQUIPMENT REQUIRED

1. Hewlett-Packard 9825B desktop computer
or
Hewlett-Packard 9825A with the followings ROM's:
 - a. general I/O
 - b. extended I/O
 - c. advanced programming
 - d. string variable
2. Hewlett-Packard (HP) 9895/9885 flexible disk drive ROM
3. HP 98034A (HP-IB) interface bus
4. HP 98035A real-time clock
5. Printer for computer (such as HP 7245, HP 9866, or HP 9876)
6. HP 3495A scanner with high speed controller and low-thermal relay options
7. HP 3455A digital voltmeter
8. HP 9885M flexible disk drive

"FLUX15"

IDENTIFICATION OF SCANNER CHANNELS

SCANNER CHANNEL

INPUT SIGNAL

0	(not used)
1	Clock from controller
2	Multiplexed Heat Flux
3	Multiplexed Temperature
4	Auxiliary # 1 Heat Flux
5	Auxiliary # 1 Temperature
6	Auxiliary # 2 Heat Flux
7	Auxiliary # 2 Temperature
8	Auxiliary # 3 Heat Flux
9	Auxiliary # 3 Temperature
10	Auxiliary # 4 Heat Flux
11	Auxiliary # 4 Temperature
12	Auxiliary # 5 Heat Flux
13	Auxiliary # 5 Temperature
14	Calibration Voltage Source
15-20	(not used)

"FLUX15"

PROGRAM LISTING

```

0: "This program is called FLUX15; it performs A/D conversion and storage":
1: "of data from the thermal loss system, either in real time or from ":
2: "analog tape. The calibration information and data are stored in two":
3: "separate files, the names of which are selected in the program by ":
4: "the user. Up to 15 sensors may be used":
5: "Version: 2 March 1982 ** RPL ":
6:
7: prt "To resume taking data after program has been stopped during data"
8: prt "collection, execute   cont 65";prt ";prt ""
9:
10: "SCANNER CHANNELS":
11: "#0 --not used":
12: "#1 --clock":
13: "#2 --MPX HFS":
14: "#3 --MPX TMP":
15: "#4 --AUX 1 HF":
16: "#5 --AUX 1 T":
17: "#6 --AUX 2 HF":
18: "#7 --AUX 2 T":
19: "#8 --AUX 3 HF":
20: "#9 --AUX 3 T":
21: "#10--AUX 4 HF":
22: "#11--AUX 4 T":
23: "#12--AUX 5 HF":
24: "#13--AUX 5 T":
25: "#14--calibration voltage source":
26:
27:
28: dim H[15],T[15],A[5],B[5],G[3],S[5],H$[40],D[2,5],C[5]
29: dim R[2],A$[6],B$[3,80],C$[6],D$[80],X[4,15],E$[32],Y[2,5],G$[40]
30: getk "KEYS"
31: rem 7;fmt 3,f3.0;ll0 7;0-U
32: wrt 722,"F1R3T2M3A0H0D0"

```

```

33: ent "Printer Select Code=?",N
34: if N#706;goto +2
35: wtb N,27,40,65
36: dsp "REMOVE PROGRAM FLEXIBLE DISK!";stp
37: dsp "INSERT DATA FLEXIBLE DISK!";stp
38: wrt 9,"A/U2C/U1D3000/U3=02/U3D2000"
39: if N=706;wtb 706,27,85
40:
41: "CLOCK LOW":-6.8+G[1]
42: "CLOCK HIGH":5.8+G[2]
43: "SYNC LEVEL":-3.8+G[3]
44:
45: prt "CLOCK LOW",G[1]
46: prt "CLOCK HIGH",G[2]
47: prt "SYNC",G[3];prt " ";prt " "
48: ent "Enter # of HFS multiplexed",L
49: ent "Enter # of TMP multiplexed",H
50: ent "Enter # of Auxiliary sensors",A
51: ent "Do you want to calibrate?",r1
52: if r1=1;c11 "CAL"
53: fmt 2/,78"*/,78"*/,2;wrt N;fmt
54: ent "Enter 6 character data file name",A$
55: ent "Number of data records=? (app.1.2/min)",Q:Q+20+Q
56: open A$,Q
57: asgn A$,1
58: ent "Enter first line of heading",B$[1];wrt N,B$[1]
59: ent "Enter second line of heading",B$[2];wrt N,B$[2]
60: ent "Enter third line of heading",B$[3];wrt N,B$[3]
61: for I=1 to 3
62: sprt 1,B$[I]
63: next I
64: sprt 1,H,L
65: dsp "Press Continue to Start Data";stp
66: dsp "Waiting for sync signal"
67: c11 'SYNC'
68: dsp "In Sync"

```

```

69: cll 'CLOCK'
70: wrt 9,"U2G"
71: for i=1 to H
72: cll 'MPXSCAN'
73: S[i]+H[i];S[2]+T[i]
74: cll 'CLOCK'
75: next i
76: cll 'AUXSCAN'
77: for i=1 to A;S[i]+A[i];C[i]+B[i];next i
78: wrt 9,"U2V";red 9,E/E/60000+E;fmt 4,f6.2
79: U+1+U
80: sprt 1,U,E,H[*],A[*],T[*],B[*],C,D,F
81: T[11]*10+T[11];fmt "Core T= ",f5.2,2x,"Time: ",f6.2," min."
82: wrt 0,T[11],E;fmt
83: if V=1;jmp 4
84: cll 'SYNC'
85: cll 'CLOCK'
86: goto 71
87: lcl 7;dsp "Data Collection Ended"
88: wait 1000;cll 'DUPE'
89: end
90:
91: "SYNC":
92: fmt 3,f3.0;wrt 709.3,2
93: trg 722;red 722,R;if R>G[3];goto +0
94: wait 5;trg 722;red 722,R;if R>G[3];goto -1
95: wait 5;trg 722;red 722,R;if R>G[3];goto -2
96: trg 722;red 722,R;if R<G[3];goto +0
97: wait 5;trg 722;red 722,R;if R<G[3];goto -1
98: ret
99:
100: "CLOCK":
101: wrt 709.3,1
102: trg 722;red 722,R;if R>G[1];goto +0
103: wait 5;trg 722;red 722,R;if R>G[1];goto -1
104: ret

```

```

105: "MPXSCAN":
106: wrt 9,"ULG"
107: wrt 9,"TIME"
108: oni 9,"TIME"
109: eir 9;0+J;0+S[1];0+S[2]
110: wrt 709.3,2;trg 722;red 722,R[1];wrt 709.3,3;trg 722;red 722,R[2]
111: R[1]+S[1]+S[1];R[2]+S[2]+S[2];J+1+J
112: gto -2;if P=1;0+P;gto +1
113: S[1]/J+S[1];S[2]/J+S[2]
114: ret
115:
116: "TIME":
117: l+P
118: iret
119:
120: "AUXSCAN":
121: oni 9,"TIME"
122: for I=1 to 5;0+S[I]+C[I];next I
123: for I=1 to A
124: wrt 9,"U3G"
125: eir 9;0+J
126: 2(I-1)+4+B;8+1+G
127: wrt 709.3,B;trg 722;red 722,R[1];wrt 709.3,G;trg 722;red 722,R[2]
128: R[1]+S[1]+S[1];R[2]+C[1]+C[1];J+1+J
129: gto -2;if P=1;0+P;gto +1
130: S[1]/J+S[1];C[1]/J+C[1]
131: next I
132: ret
133:
134: "CAL":
135: "Waiting for sync "+G$
136: "Calibration data is being read"+H$
137: ent "Enter 6 character cal. file name",C$
138: fmt 4,/"CALIBRATION FILE NAME:",2x,C6;N+.4+M;wrt M,C$
139: open C$,3
140: asgn C$,2

```

```

141: ent "Enter heading for cal. file",D$
142: wrt N,D$;sprt 2,D$
143: dsp "Calibrate heat flux sensors";stp
144: dsp "Cal. HFS, LOW voltage (0 mv)";stp
145: cll 'VOLR'
146: S[l]→r2
147: fmt 4,2/,"HFS LOW CALIBRATION, INPUT V= ",f7.3," MV",/;N+.4→M;wrt M,r2
148: "Press CONTINUE to take reading"→E$
149: dsp E$;stp
150: dsp G$
151: cll 'SYNC'
152: cll 'CLOCK'
153: dsp H$
154: for I=1 to L
155: cll 'CALHFS'
156: S[l]→X[l,I]
157: cll 'CLOCK'
158: next I
159: cll 'CALAH'
160: for I=1 to A;S[l]→Y[l,I];next I
161: for I=1 to L
162: fmt 1,f2.0,5x,f10.6
163: N+.1→M;wrt M,I,X[l,I]
164: next I
165: fmt 2,/,"AUXILIARY HEAT FLUX SENSORS:",/;N+.2→M;wrt M
166: N+.1→M
167: for I=1 to A;wrt M,I,Y[l,I];next I
168: ent "Repeat Calibration?",r1
169: if r1=1;goto 144
170: dsp "Cal. HFS, HIGH voltage (5 mv)";stp
171: cll 'VOLR'
172: S[l]→r3
173: fmt 4,2/,"HFS HIGH CALIBRATION, INPUT V= ",f7.3," MV",/;N+.4→M;wrt M,r3
174: dsp E$;stp
175: dsp G$
176: cll 'SYNC'

```

```

177: cll 'CLOCK'
178: dsp H$
179: for I=1 to L
180: cll 'CALHFS'
181: S[1]+X[2,I]
182: cll 'CLOCK'
183: next I
184: cll 'CALAH'
185: for I=1 to A;S[I]+Y[2,I];next I
186: for I=1 to L
187: N+.1+M;wrt M,I,X[2,I]
188: next I
189: N+.2+M;wrt M;N+.1+M
190: for I=1 to A;wrt M,I,Y[2,I];next I
191: ent "Repeat Calibration?",r1
192: if r1=1;goto 170
193: dsp "CALIBRATE TEMPERATURE";stp
194: ent "Low T in degrees C = ?",r6
195: fmt 4,2/,"LOW T CALIBRATION TEMP.= ",f6.2," C"/;N+.4+M;wrt M,r6
196: dsp E$;stp
197: dsp G$
198: cll 'SYNC'
199: cll 'CLOCK'
200: dsp H$
201: for I=1 to H
202: cll 'CALTMP'
203: S[1]+X[3,I]
204: cll 'CLOCK'
205: next I
206: cll 'CALAT'
207: for I=1 to A;C[I]+D[1,I];next I
208: for I=1 to H
209: N+.1+M;wrt M,I,X[3,I]
210: next I
211: fmt 2,/,"AUXILIARY TEMPERATURE SENSORS: ",/;N+.2+M;wrt M
212: N+.1+M

```

```

213: for I=1 to A;wrt M,I,D[1,I];next I
214: ent "Repeat Calibration?",r1
215: if r1=1;goto 194
216: ent "High T in degrees C = ?",r7
217: fmt 4,2/,"HIGH T CALIBRATION TEMP.= ",f6.2," C",/;N+.4+M;wrt M,r7
218: dsp E$;stp
219: dsp G$
220: cll 'SYNC'
221: cll 'CLOCK'
222: dsp H$
223: for I=1 to H
224: cll 'CALTMP'
225: S[I]+X[4,I]
226: cll 'CLOCK'
227: next I
228: cll 'CALAT'
229: for I=1 to A;C[I]+D[2,I];next I
230: for I=1 to H
231: N+.1+M;wrt M,I,X[4,I]
232: next I
233: N+.2+M;wrt M;N+.1+M
234: for I=1 to A;wrt M,I,D[2,I];next I
235: ent "Repeat Calibration?",r1
236: if r1=1;goto 216
237: sprt 2,r2,r3,r4,r5,r6,r7
238: sprt 2,X[*]
239: sprt 2,Y[*]
240: sprt 2,D[*]
241: dsp "Calibration Completed";stp
242: ret
243:
244: "CALHFS":
245: wrt 9,"ULG"
246: oni 9,"TIME"
247: eir 9;0+J;0+S[1]
248: wrt 709.3,2

```

```

249: trg 722;red 722,R[1];R[1]+S[1]+S[1];J+1+J
250: gto -1;if P=1;0+P;gto +1
251: S[1]/J+S[1]
252: ret
253:
254: "CALTMP":
255: wrt 9,"ULG"
256: oni 9,"TIME"
257: eir 9;0+J;0+S[1]
258: wrt 709.3,3
259: trg 722;red 722,R[1];R[1]+S[1]+S[1];J+1+J
260: gto -1;if P=1;0+P;gto +1
261: S[1]/J+S[1]
262: ret
263:
264: "CALAH":
265: oni 9,"TIME"
266: for I=1 to 5;0+S[I];next I
267: for I=1 to A
268: wrt 9,"U3G"
269: eir 9;0+J
270: 2(I-1)+4+B
271: wrt 709.3,B
272: trg 722;red 722,R[1];R[1]+S[I]+S[I];J+1+J
273: gto -1;if P=1;0+P;gto +1
274: S[I]/J+S[I]
275: next I
276: ret
277:
278: "CALAT":
279: oni 9,"TIME"
280: for I=1 to 5;0+C[I];next I
281: for I=1 to A
282: wrt 9,"U3G"
283: eir 9;0+J
284: 2(I-1)+5+G

```

```

285: wrt 709.3,G
286: trg 722;red 722,R[2];R[2]+C[I]+C[I];J+1-J
287: gto -1;if P=1;0-P;gto +1
288: C[I]/J-C[I]
289: next I
290: ret
291: "VOLT":
292: wrt 722,"R1T1";wrt 709.3,14
293: dsp "Press CONT to read input volts";stp
294: wrt 722,"T2";J+S[1];dsp "READING CALIBRATION VOLTAGE"
295: for I=1 to 10
296: trg 722;red 722,R[1];R[1]+S[1]+S[1];wait 200
297: next I
298: S[1]/10+S[1];1000*S[1]+S[1]
299: wrt 722,"R3"
300: ret
301: "DUPE":
302: dsp "Press continue to duplicate data";stp
303: dsp "INSERT TAPE FOR DATA DUMP";stp
304: dsp "DATA IS BEING RECORDED ON TAPE"
305: trk 0;rew;ert 0
306: dump C$,0
307: dump A$,1
308: rew
309: dsp "REMOVE ORIGINAL DATA DISK";stp
310: dsp "INSERT DISK FOR DUPLICATE DATA";stp
311: dsp "DATA BEING RECORDED ON DISK"
312: open C$,3;open A$,Q
313: load C$,0
314: load A$,1
315: rew
316: dsp "DATA DUPLICATION COMPLETED"
317: ret

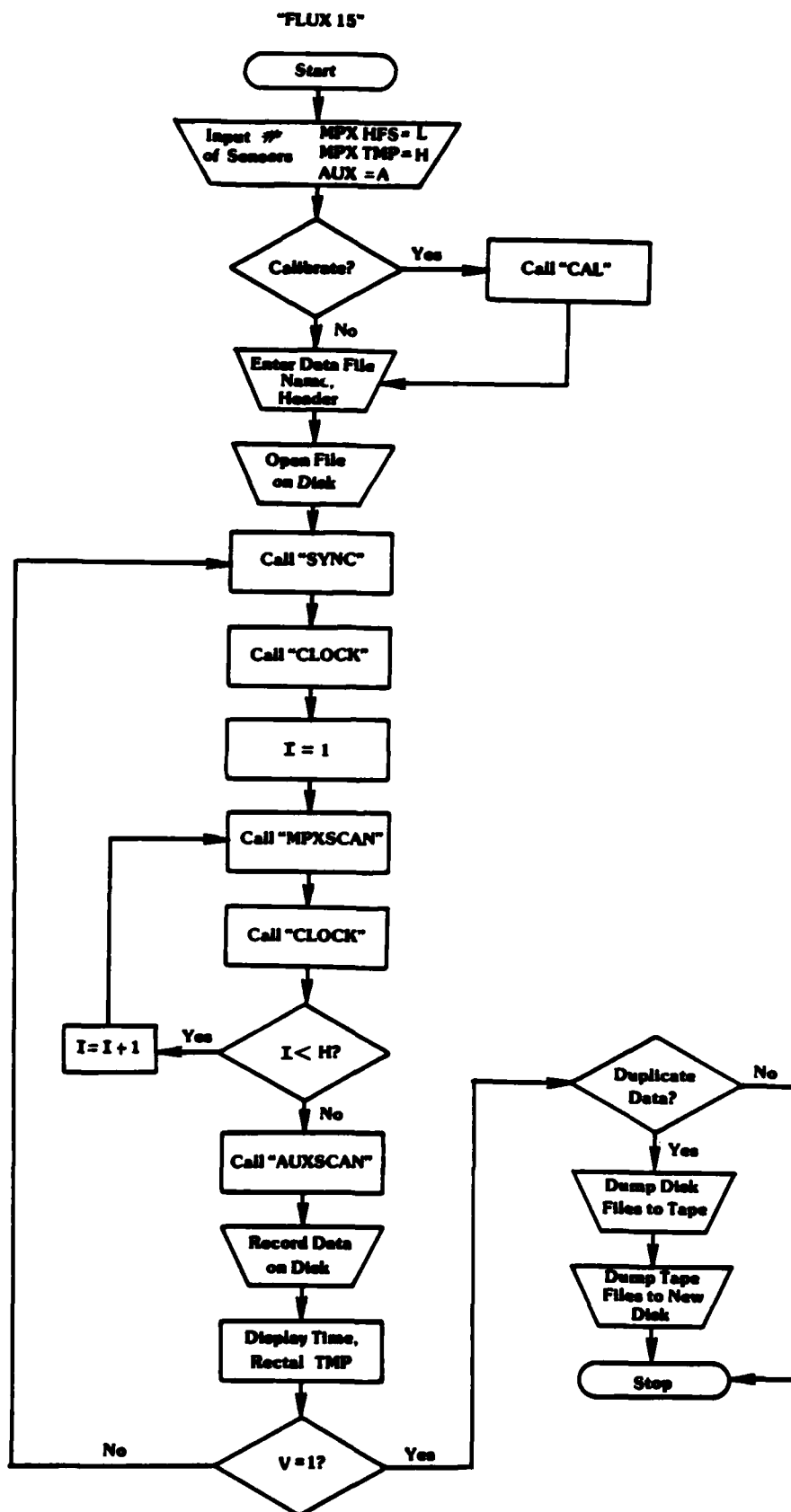
```

"FLUX15"

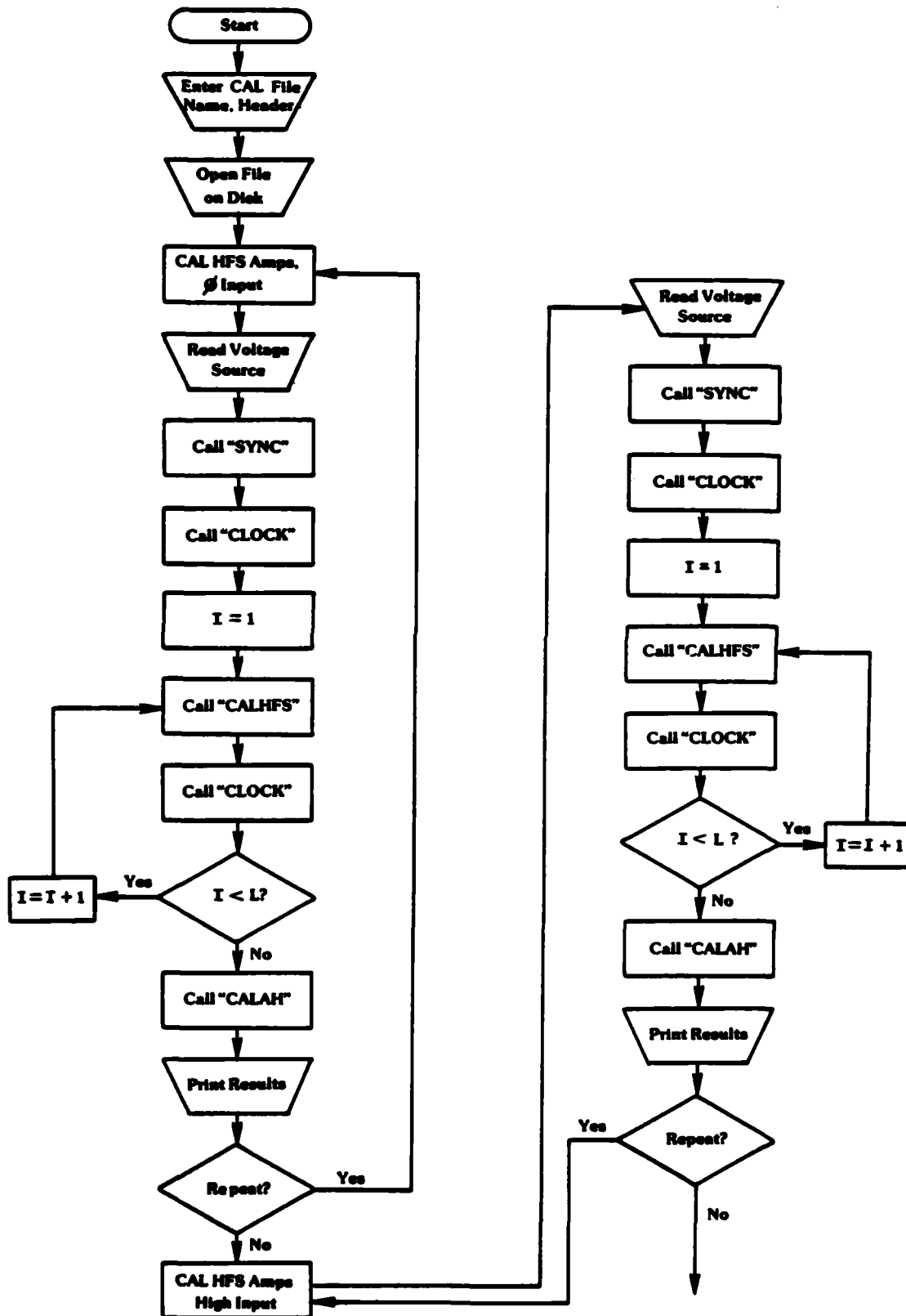
VARIABLE ASSIGNMENTS

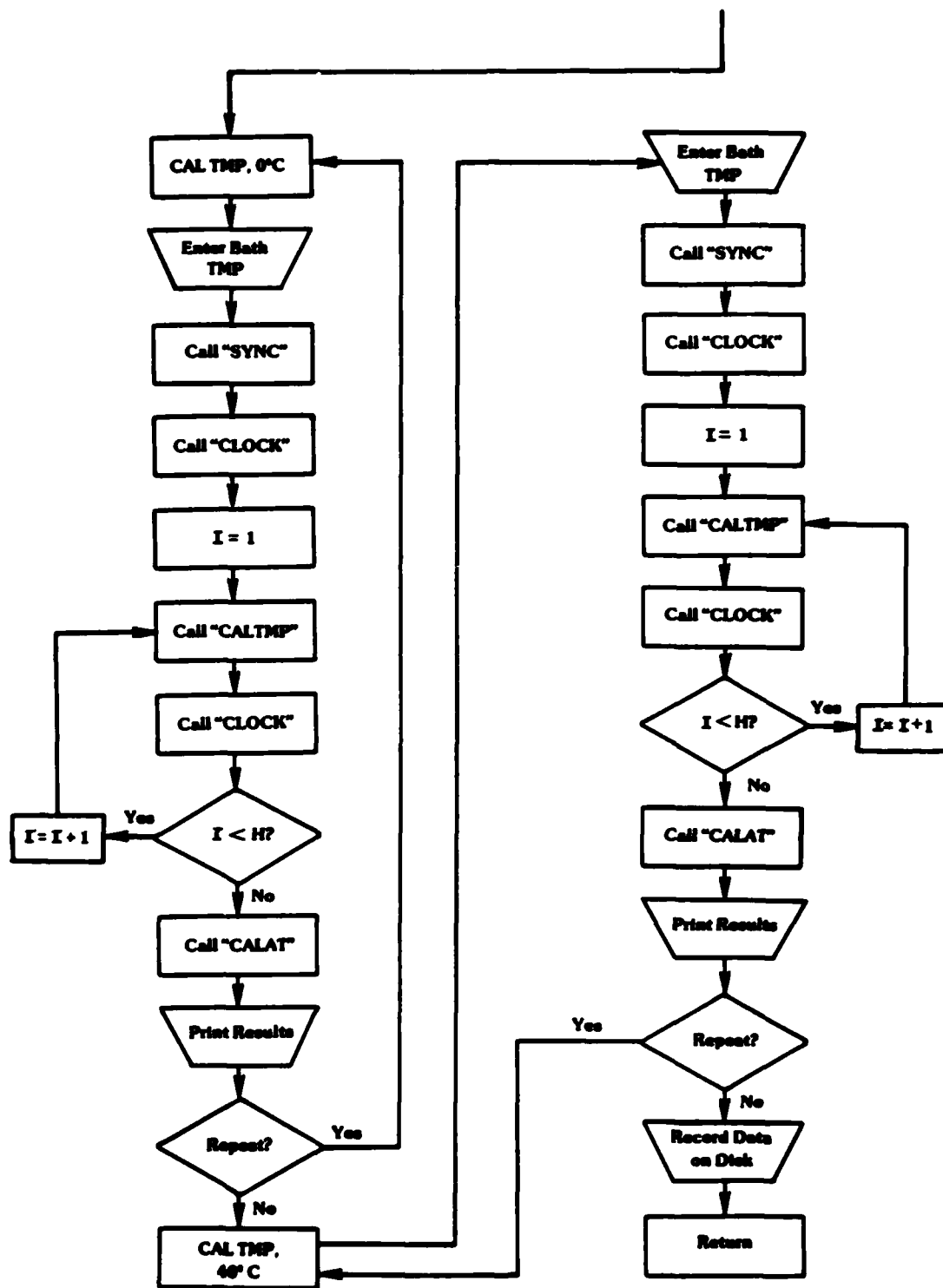
A	number of auxiliary sensors
B	used
C, D, F	variables stored on flexible disk but currently not assigned
E	elapsed time in minutes
G	used
H	number of temperatures multiplexed
I, J	used as counters
L	number of heat flux sensors multiplexed
M	used as printer and format number
N	select code of printer
P	used as flag for expiration of scan time
Q	number of data records
R	temporary storage of DVM reading
U	number of current data record
V	flag for ending data collection
A[*]:	A[I] is output of auxiliary heat flux sensor # I
B[*]:	B[I] is output of auxiliary temperature sensor # I
C[*]:	used
D[*]:	calibration signals
D[1,I]	auxiliary temperature sensor # I low calibration signal
D[2,I]	auxiliary temperature sensor # I high calibration signal
G[*]:	synchronization signals
G[1]	voltage set as clock low level
G[2]	voltage set as clock high level
G[3]	voltage set as synchronization pulse level
H[*]:	H[I] is output of multiplexed heat flux sensor # I
R[*]:	temporary storage of DVM readings
S[*]:	temporary storage of averaged DVM readings
T[*]:	T[I] is output of multiplexed temperature sensor # I
X[*]:	calibration signals
X[1,I]	multiplexed heat flux sensor # I low calibration signal
X[2,I]	multiplexed heat flux sensor # I high calibration signal
X[3,I]	multiplexed temperature sensor # I low calibration signal
X[4,I]	multiplexed temperature sensor # I high calibration signal
Y[*]:	calibration signals
Y[1,I]	auxiliary heat flux sensor # I low calibration signal
Y[2,I]	auxiliary heat flux sensor # I high calibration signal
A\$	data file name
B\$	header for data file
C\$	calibration file name
D\$	header for calibration file
E\$	used
G\$	used
H\$	used

r1	yes/no flag
r2	HFS low cal input (mV)
r3	HFS high cal input (mV)
r4	currently not assigned
r5	currently not assigned
r6	low temperature cal input ($^{\circ}\text{C}$)
r7	high temperature cal input ($^{\circ}\text{C}$)

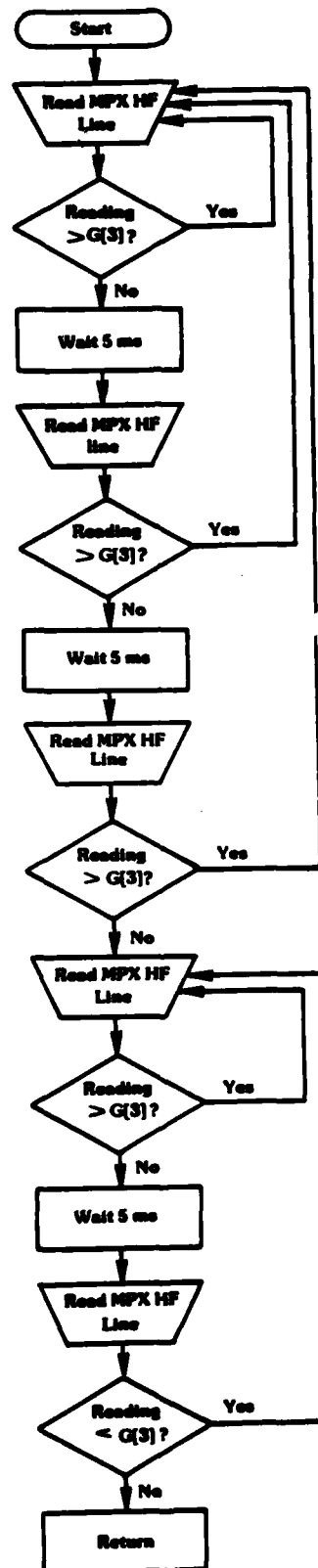


Subroutine: "CAL"

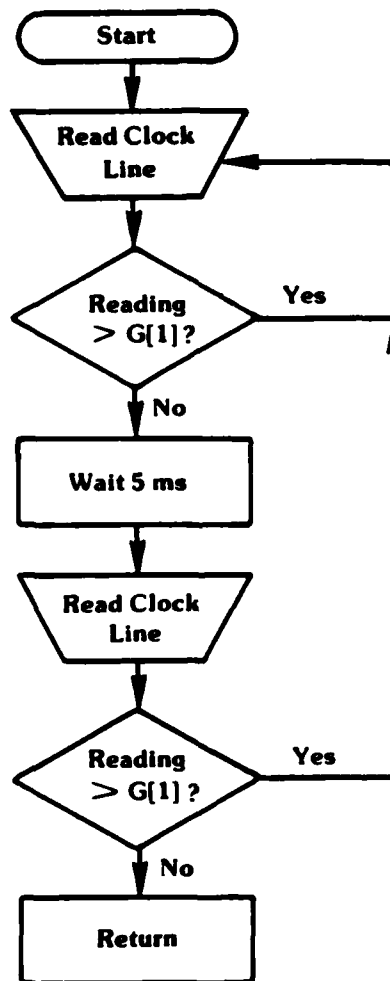




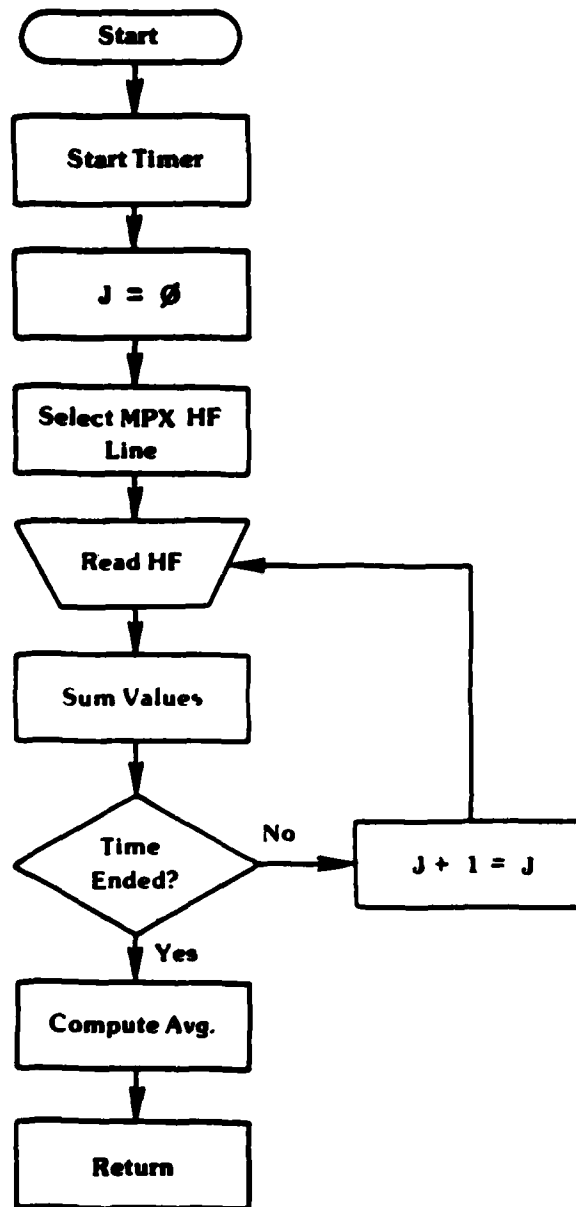
Subroutine: "SYNC"



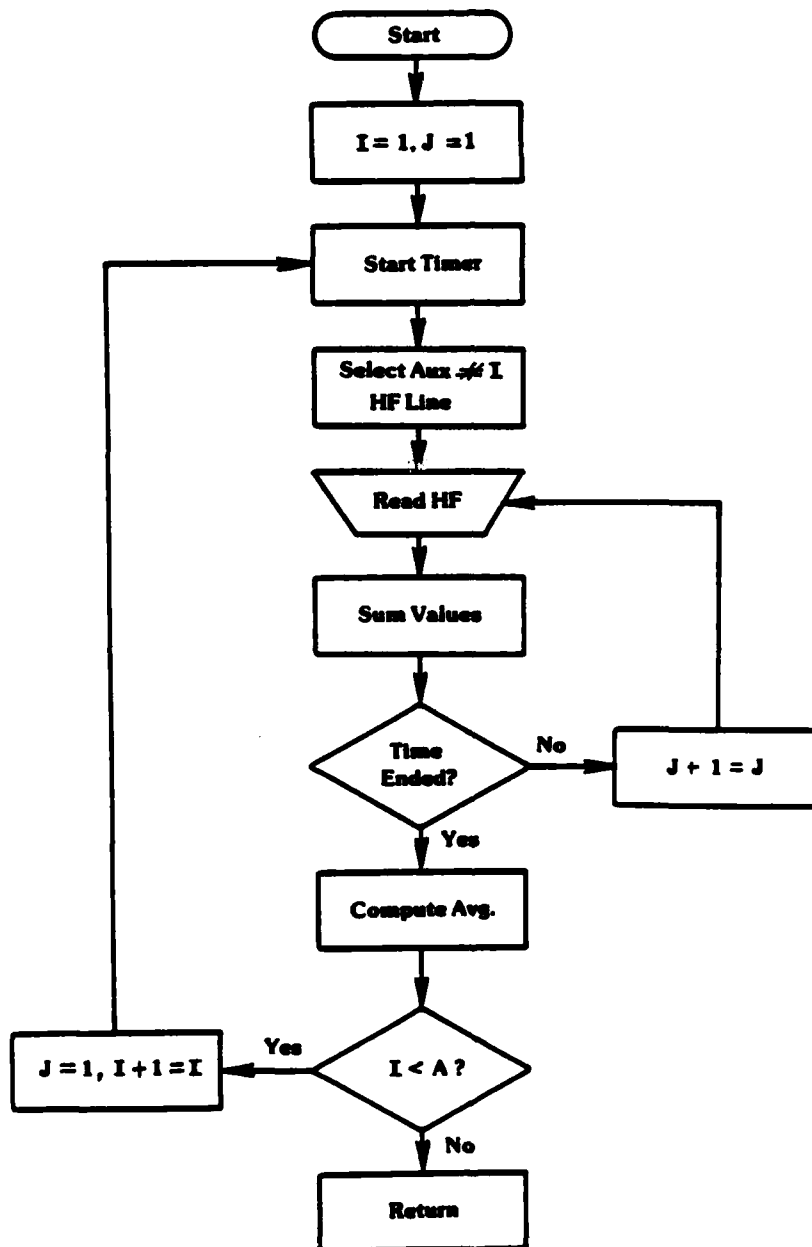
Subroutine: "CLOCK"



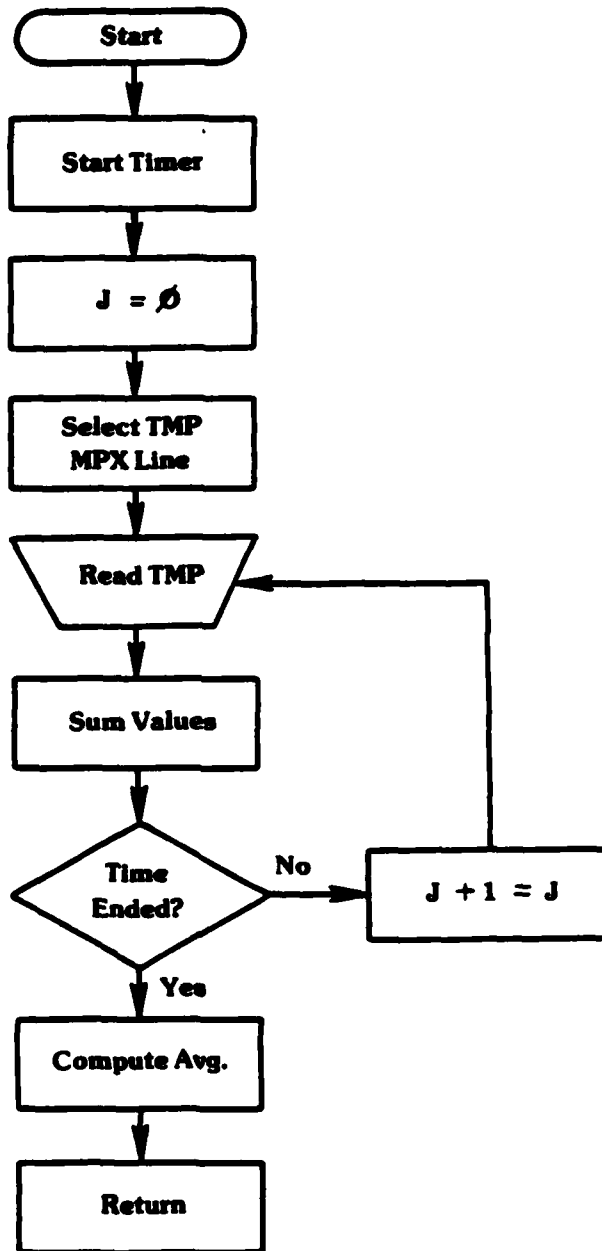
Subroutine: "CALHFS"



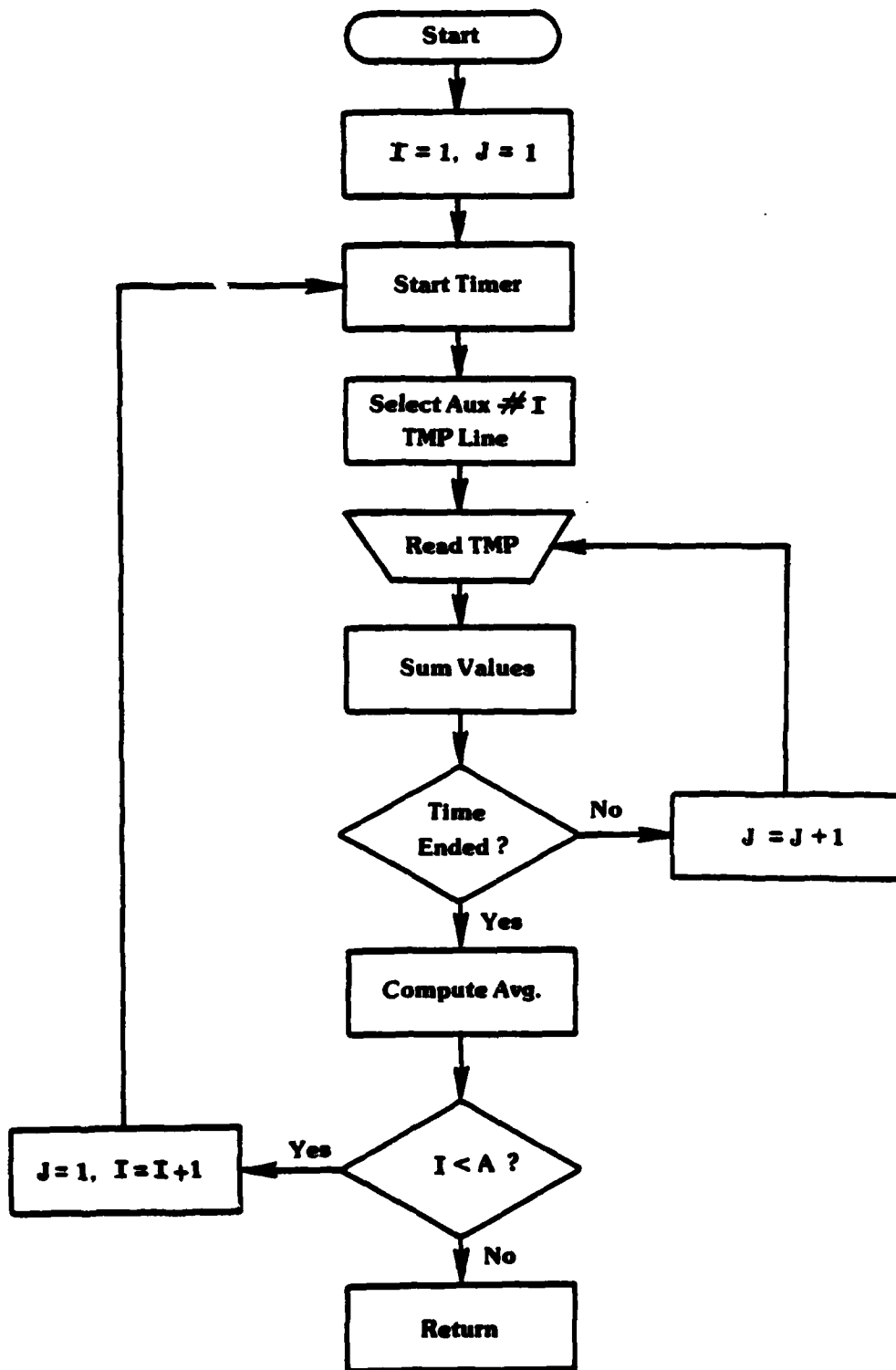
Subroutine: "CALAH"



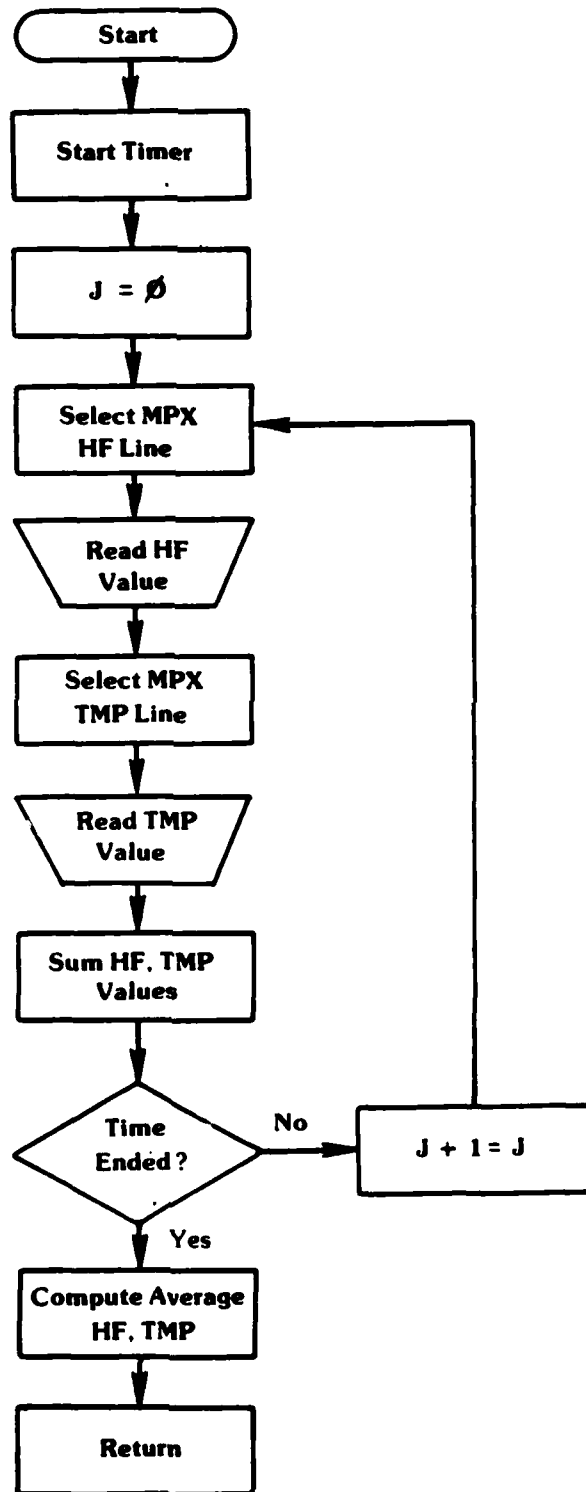
Subroutine: "CALTMP"



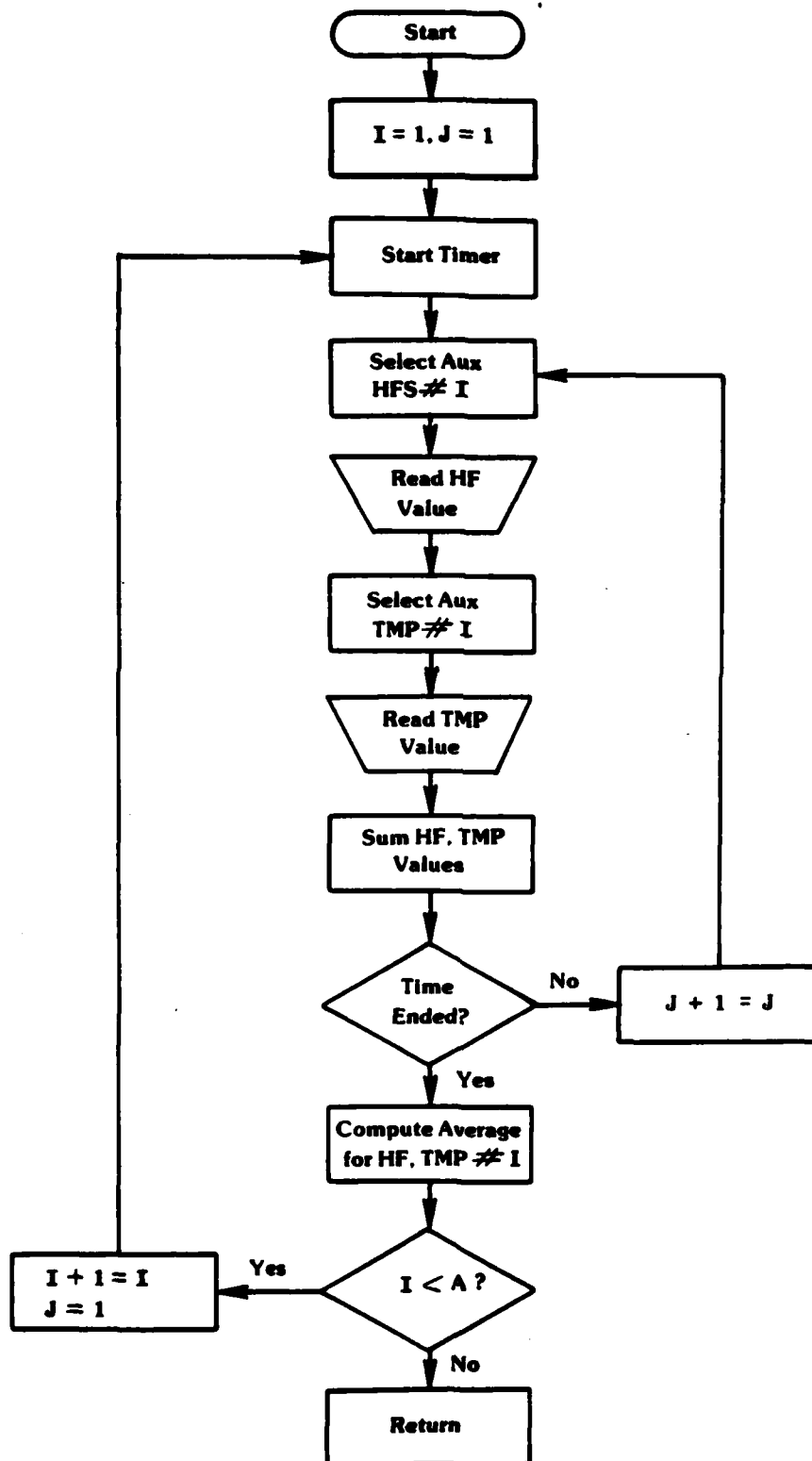
Subroutine: "CALAT"



Subroutine: "MPX SCAN"



Subroutine: "AUXSCAN"



"HEAT15"

EQUIPMENT REQUIRED

1. Hewlett-Packard (HP) 9825B desktop computer
or
HP 9825A computer with the following ROM's:
 - a. general I/O
 - b. extended I/O
 - c. advanced programming
 - d. string variable
2. HP 9895/9885 flexible disk drive ROM
3. HP 9895 dual flexible disk drive
4. Printer, such as HP 7245, HP 9866, HP 9876
5. HP 98034A (HP-IB) interface bus

"HEAT15"

PROGRAM LISTING

```

0: "This program is called HEAT15; it converts voltage values from data":
1: "files created by FLUX15 to actual heat flux and temperatures":
2: "Data must already be on double disk for analysis in this version":
3: "Version: 10 February 1982 ** RPL":
4:
5: dim C$(6),E$(6),D$(80),X(4,15),Y(2,5),V(2,5),N(3),Z(2,15),W(15),A(5,2)
6: dim Q(5),A$(6),S(2,15),B$(3,80),F$(3,80),D(2,15),E(2,5),K(2,5)
7: dim H(15),T(15),C(5),B(5),F(15),M(12),P(5),I(15)
8:
9: ent "Printer Select Code=?",N;if N=706 or N=606;wtb N,27,40,65
10:
11: getk "KEY3"
12: dsp "INSERT DATA DISK in drive 0";stp
13: dsp "INSERT NEW DATA DISK in drive 1";stp
14: drive 0,707
15: ent "Name of Calibration file?",C$
16: ent "Name of Data file wanted?",E$
17: ent "Name for new analyzed data file?",A$
18: asgn C$,1;sread 1,D$,r2,r3,r4,r5,r6,r7
19: sread 1,X[*],Y[*],V[*]
20: ent "# records in original data file?",r20
21: drive 1,707;open A$,r20;drive 0,707
22: asgn E$,3;asgn A$,4,1
23: cfg 1;ent "Do you want printout?",r1;if r1=0;sfg 1
24: if flgl;gto "ONE"
25: wrt N,"Calibration file: ",C$;wrt N;wrt N,D$;wrt N
26: fmt 1,/,,"HFS Calibration input voltages (mv)",/,7x,f7.3,15x,f7.3,2/
27: N+.1+M;wrt M,r2,r3
28: fmt 2,f2.0,5x,f10.6,5x,f10.6;N+.2+M
29: wrt N,"Low & High cal. output signals for HFS (Volts):";wrt N
30: for I=1 to 10;wrt M,I,X(1,I),X(2,I);next I
31: fmt 4,/,,"Auxiliary HFS",/;N+.4+M;wrt M;N+.5+M
32: fmt 5,"A",f1.0,5x,f10.6,5x,f10.6

```

```

33: for I=1 to 5
34: wrt M,I,Y{1,I},Y{2,I};next I
35: fmt 3,/, "Temperature Calibration input values (deg. C):";wrt N;fmt
36: fmt 3,/,f6.2,5x,f6.2,2;/N+.3+M;wrt M,r6,r7
37: wrt N,"Low & High cal. output signals for TMP (Volts):";wrt N;N+.2+M
38: for I=1 to 12;wrt M,I,X{3,I},X{4,I};next I
39: fmt 4,/, "Auxiliary Temperatures Sensors",/;N+.4+M;wrt M;N+.5+M
40: for I=1 to 5;wrt M,I,V{1,I},V{2,I};next I
41:
42: "ONE":
43: asgn "ARRAY15",2,1
44: sread 2,N[*],2[*],W[*],A[*],Q[*]
45: if flgl;goto "TWO"
46:
47:
48: if N=706 or N=606;wtb N,27,85
49: wrt N,"Sensor information stored in ARRAY15:"
50: fmt 1,/, "HFS= ",f2.0,5x,"# TMP sensors= ",f2.0,5x,"# AUX sensors= ",z
51: N+.1+M;wrt M,N{1},N{2};fmt 1,f2.0;wrt M,N{3}
52: fmt 2,/, "Ser. #",3x,"Cal. Const.",2x,"Wt. Factor",/
53: wrt N;fmt
54: fmt 1,f2.0,4x,f4.0,5x,f6.2,6x,f6.4
55: for I=1 to 15
56: wrt M,I,2{1,I},2{2,I},W{I}
57: next I
58: wrt N;fmt 1,"A",f1.0,4x,f4.0,5x,f6.2,6x,f6.4
59: for I=1 to 5;wrt M,I,A{1,I},A{1,2},Q{I};next I
60:
61: "THREE":
62: ent "Do you want to change ARRAY15?",r1
63: if r1;cll 'SNSR'
64: if r1;goto "TWO"
65: ent "Modify ARRAY15 again?",r1
66: if r1;goto 63
67:
68: "TWO":

```

```

69: ent "Height of subject (inches)=?",A;2.54*A+A
70: ent "Weight of subject (pounds)=?",B;B*.4536+B
71: A=.725*B*.425*71.84+r8;r8/10000+r8
72: for I=1 to 15;r8*W[I]-W[I];next I
73: for I=1 to 5;r8*Q[I]-Q[I];next I
74: cll 'LINE'
75: fmt 4/,"Name of original data file: ",c6,/
76: wrt N,E$
77: fmt ,"Heading from data file: ";wrt N;fmt
78: for I=1 to 3
79: sread 3,B$[I];next I
80: for I=1 to 3;wrt N,B$[I];next I
81: sread 3,H,L;0+P
82: for I=1 to 3
83: ent "Enter heading (3 lines avail.)",F$(I)
84: next I
85: sprt 4,C$,D$,E$,B$,F$
86: sprt 4,N[*],r8
87: dsp "DATA ANALYSIS RUNNING"
88: cll 'ALYZE'
89:
90: "LINE":
91: if flgl;goto +7
92: fmt 5/;wrt N;fmt
93: wrt N,"PARAMETERS USED TO CALCULATE HEAT LOSS & TEMP. FROM DATA FILE:"
94: wrt N;wrt N
95: fmt 1,"Height= ",f5.1," cm",5x,"Weight= ",f6.2," Kg",5x,z
96: N+.1+M;wrt M,A,B
97: fmt 1,"Body surface area= ",f5.2," square meters",/;wrt M,r8
98: for I=1 to N[1]
99: 100*(X[2,I]-X[1,I])/(r3-r2)+S[1,I];if S[1,I]=0;1+S[1,I]
100: X[1,I]-S[1,I]*(r2/1000)+D[1,I]
101: next I
102: for I=1 to N[2]
103: (X[4,I]-X[3,I])/(r7-r6)+S[2,I];if S[2,I]=0;1+S[2,I]
104: X[3,I]-S[2,I]*r6+D[2,I]

```

```

105: next I
106: for I=1 to N[3]
107: 1000*(Y[2,I]-Y[1,I])/(r3-r2)+E[1,I]; if E[1,I]=0; 1+E[1,I]
108: Y[1,I]-E[1,I]*(r2/1000)+K[1,I]
109: (V[2,I]-V[1,I])/(r7-r6)+E[2,I]; if E[2,I]=0; 1+E[2,I]
110: V[1,I]-E[2,I]*r6+K[2,I]
111: next I
112: if flgl;ret
113:
114: "FOUR":
115: fmt 1,2/,5x,"Ser. #",4x,"Const.",4x,"F Area",5x,"Gain",4x,"Offset",9x,z
116: N+.1+M;wrt M
117: fmt 1,"T Gain",4x,"T Offset",2/;wrt M
118: fmt 1,f2.0,4x,f4.0,5x,f5.1,5x,f5.3,5x,f5.1,5x,f6.3,10x,f5.3,5x,f5.2
119: for I=1 to 12
120: wrt M,I,Z[1,I],Z[2,I],W[I],S[1,I],D[1,I],S[2,I],D[2,I]
121: next I
122: wrt N
123: fmt 1,"A",f1.0,4x,f4.0,5x,f5.1,5x,f5.3,5x,f5.1,5x,f6.3,10x,f5.3,5x,f5.2
124: for I=1 to 5
125: wrt M,I,A[I,1],A[I,2],Q[I],E[1,I],K[1,I],E[2,I],K[2,I]
126: next I
127: dsp "Make necessary changes, then continue";stp
128: ent "Did you make any changes?";rl
129: if rl;wrt N;wrt N;wrt N;goto "FOUR"
130: ret
131:
132: "ALYZE":
133: on end 3,"LAST"
134:
135: "FIVE":
136: sread 3,U,E,H[*],C[*],F[*],B[*],C,D,E
137: E-P+G;E+P
138: for I=1 to N[1]
139: 1000((H[I]-D[1,I])/S[1,I])*Z[2,I]+F[I]
140: F[I]*W[I]*G*60+I[I];I[I]+r9+r9

```

```

141: next I
142: for I=1 to N[3]
143: 1000*((C[I]-K[I,1])/E[1,I])*A[I,2]*F[10+I]
144: F[I+10]*Q[I]*G*60*I[I+10];I[I+10]+r9+r9
145: next I
146: for I=1 to N[2]
147: (T[I]-D[2,I])/S[2,I]+M[I]
148: next I
149: for I=1 to N[3]
150: (B[I]-K[2,I])/E[2,I]+P[I]
151: next I
152: sprt 4,U,E,F[*],M[*],P[*]
153: goto "FIVE"
154: ret
155:
156: "LAST":
157: ent "Print total heat losses?",r1
158: goto 173;if r1=1;goto +1
159: fmt 1,2/,"Sensor #",3x,"Total Heat Loss (Joules)",5x," (Kcal)",/
160: N+.1+M;wrt M
161: fmt 1,3x,f2.0,17x,f10.0,5x,f9.4
162: for I=1 to N[1]
163: wrt M,I[I],I[I]/1000*.2389
164: next I
165: wrt N
166: fmt 1,3x,"A",f1.0,17x,f10.0,5x,f9.4
167: wrt N
168: for I=1 to N[3]
169: wrt M,I,I[10+I],I[10+I]/1000*.2389
170: next I
171: fmt 2/,"Total Body Heat Loss= ",f10.0,5x,f9.4
172: wrt N,r9,r9/1000*.2389;fmt
173: if N=706;wtb N,27,85
174: ent "DATA ANALYSIS FINISHED; another run?",r1
175: if r1;goto 12
176: dsp "PROGRAM FINISHED"

```

```

177: end
178:
179: "SNSR":
180: cll 'ENTER'
181: cll 'PRINT'
182: cll 'CREATE'
183: ret
184:
185: "ENTER":
186: ent "Number of MPX HFS = ?",N[1],"Number of T sensors = ?",N[2]
187: ent "Number of AUX sensors= ?",N[3]
188: for I=1 to 10
189: fmt "Sensor # ",f2.0;wrt 0,I;stp
190: ent "Serial #=?",Z[1,I],"Cal. const.=?",Z[2,I],"Weighting factor=?",W[I]
191: next I
192: for I=1 to 5
193: fmt "AUX # ",f2.0;wrt 0,I;stp
194: ent "Serial #=?",A[I,1],"Cal. const.=?",A[I,2],"Weighting factor=?",Q[I]
195: next I
196: ret
197:
198: "PRINT":
199: fmt 3,3/,78"*",/;N+.3+M;wrt M
200: N+.1+M;fmt 1,2/, "# of HFS= ",f2.0,5x," # of T sensors= ",f2.0,5x,z
201: wrt M,N[1],N[2]
202: fmt 1," # of AUX sensors= ",f2.0;wrt M,N[3]
203: N+.1+M;fmt 1,7x,2x," #",5x,"Const.",2x,"F. area",/;wrt M
204: for I=1 to 10
205: fmt 1,f2.0,4x,f4.0,5x,f5.1,5x,f6.4
206: wrt M,I,Z[1,I],Z[2,I],W[I]
207: next I
208: fmt 2,/, "AUXILIARY SENSORS",/;N+.2+M;wrt M
209: N+.1+M
210: for I=1 to 5
211: wrt M,I,A[I,1],A[I,2],Q[I]
212: next I

```

```
213: N+.3+M;wrt M
214: ret
215: "CREATE":
216: drive 1
217: kill "ARRAY15";open "ARRAY15",2
218: asgn "ARRAY15",2,1
219: drive 0
220: sprt 2,N[*],Z[*],W[*],A[*],Q[*]
221: ret
```

"HEAT15"

VARIABLE LISTING

A	Height of subject in inches
B	Weight of subject in pounds
C	used, not currently assigned
D	used, not currently assigned
E	elapsed time in minutes
F	used, not currently assigned
G	used
H	number of temperature sensors multiplexed
I	used as counter
L	number of heat flux sensors multiplexed
M	printer select code plus format number
N	printer select code
P	used
U	number of current original data record
A[*]:	auxiliary sensors
A[I,1]	serial number of sensor #I
A[I,2]	heat flux calibration constant for sensor # I
B[*]:	data voltage signal for auxiliary temperatures
B[I]	value for sensor #I
C[*]:	data voltage signal for auxiliary heat flux sensors
C[I]	value for sensor #I
D[*]:	offset voltages of multiplexed sensors
D[1,I]	heat flux circuit #I
D[2,I]	temperature sensor #I
E[*]:	auxiliary sensor amplifier gains
E[1,I]	heat flux circuit # I
E[2,I]	temperature circuit #I
F[*]:	scaled heat flux (W/M^2)
F[I]	$1 \leq I \leq 10$, multiplexed sensors # I
F[I]	$11 \leq I \leq 15$, auxiliary sensor # (I-10)
H[*]:	data voltage signal for multiplexed heat flux sensors
H[I]	sensor # I
I[*]:	scaled heat loss (W)
I[J]	$1 \leq J \leq 10$, multiplexed sensor # J
I[J]	$11 \leq J \leq 15$, auxiliary sensor # (J - 10)
K[*]:	offset voltages for auxiliary sensors
K[1,I]	heat flux circuit # I
K[2,I]	temperature sensor # I
M[*]:	scaled multiplexed temperatures ($^{\circ}C$)
M[I]	$1 \leq I \leq 10$, sensor #I
M[11]	rectal temperature
M[12]	ambient temperature
N[*]:	
N[1]	number of multiplexed heat flux sensors
N[2]	number of multiplexed temperature sensors
N[3]	number of auxiliary sensors

P[*]: scaled auxiliary temperatures ($^{\circ}\text{C}$)
 P[I] sensor # I value
 Q[*]: surface area weighting factors for auxiliary sensors
 Q[I] value for sensor # I
 S[*]: gains of multiplexed circuits
 S[1,I] heat flux circuit # I
 S[2,I] temperature circuit # I
 T[*]: data voltage signal for multiplexed temperatures
 T[I] $1 \leq I \leq 10$, sensor # I
 T[11] rectal probe
 T[12] ambient probe
 V[*]: auxiliary temperature sensor calibration signals
 V[1,I] low temperature for sensor # I
 V[2,I] high temperature for sensor # I
 W[*]: surface area weighting factors for multiplexed sensors
 W[I] value for sensor # I
 X[*]: calibration output signals for multiplexed sensors
 X[1,I] low calibration for heat flux # I
 X[2,I] high calibration for heat flux # I
 X[3,I] low calibration for temperature # I
 X[4,I] high calibration for temperature # I
 Y[*]: calibration output signals for auxiliary heat flux sensors
 Y[1,I] low calibration for heat flux # I
 Y[2,I] high calibration for heat flux # I
 Z[*]: serial numbers and calibration constants for multiplexed sensors
 Z[1,I] serial number of sensor # I
 Z[2,I] calibration constant ($\text{W/M}^2\text{-mV}$) for sensor # I

 A\$ name of new file for scaled data
 B\$ header from original data file
 C\$ name of calibration file
 D\$ header of calibration file
 E\$ name of original data file
 F\$ header of new file for scaled data

 r1 yes/no flag
 r2 HFS low calibration input (mV)
 r3 HFS high calibration input (mV)
 r4 currently not assigned
 r5 currently not assigned
 r6 temperature low calibration input ($^{\circ}\text{C}$)
 r7 temperature high calibration input ($^{\circ}\text{C}$)
 r20 number of records in original data file

"SNSR15"

PROGRAM LISTING

```

0: "This program is called SNSR15; it creates the file called ARAY15 ":
1: "which contains the serial numbers, calibration constants, and ":
2: "weighting factors for the HFS":
3: "This program is to be used in conjunction with program FLUX15 only":
4: "Version: 27 January 1982 ** RPL ":
5:
6: dim N[3],Z[2,15],W[15],A[5,2],Q[5]
7: getk "KEYS"
8: dsp "Remove Program Disk";stp
9: dsp "Insert Disk for ARAY15 file";stp
10: ent "Printer Select Code=?",N
11: if N=706 or N=606;wtb N,27,40,65
12: ent "Create new ARAY15 file?",r1
13: if r1#1;goto 18
14: cll 'ENTER'
15: cll 'PRINT'
16: cll 'CREATE'
17: goto 21
18: asgn "ARAY15",1
19: sread 1,N[*];sread 1,Z[*],W[*];sread 1,A[*],Q[*]
20: cll 'PRINT'
21: ent "Modify ARAY15 file?",r1
22: if r1=0;goto +4
23: cll 'ENTER'
24: cll 'PRINT'
25: cll 'CREATE'
26: goto 67
27:
28: "ENTER":
29: ent "Number of MPX HFS = ?",N[1],"Number of MPX TMP sensors = ?",N[2]
30: ent "Number of AUX sensors=?",N[3]
31: for I=1 to 10
32: fmt "Sensor # ",f2.0;wrt 0,I;stp

```

```

33: ent "Serial #=?",Z[1,I],"Cal. const.=?",Z[2,I],"Weighting factor=?",W[I]
34: next I
35: for I=1 to 5
36: fmt "AUX # ",f2.0;wrt 0,I;stp
37: ent "Serial #=?",A[I,1],"Cal. const.=?",A[I,2],"Weighting factor=?",Q[I]
38: next I
39: ret
40:
41: "PRINT":
42: fmt 3,3/,78**",/;N+.3+M;wrt M
43: N+.1+M;fmt 1,2/,,"# of HFS= ",f2.0,5x,"# of T sensors= ",f2.0,5x,z
44: wrt M,N[1],N[2]
45: fmt 1,"# of AUX sensors= ",f2.0;wrt M,N[3]
46: N+.1+M;fmt 1,7x,2x,"#",5x,"Const.",2x,"F. area",/;wrt M
47: for I=1 to 10
48: fmt 1,f2.0,4x,f4.0,5x,f5.1,5x,f6.4
49: wrt M,I,Z[1,I],Z[2,I],W[I]
50: next I
51: fmt 2,/, "AUXILIARY SENSORS",/;N+.2+M;wrt M
52: N+.1+M
53: for I=1 to 5
54: wrt M,I,A[I,1],A[I,2],Q[I]
55: next I
56: N+.3+M;wrt M
57: ret
58:
59: "CREATE":
60: ent "Does previous ARAY15 file exist?",r1
61: if r1=1;kill "ARAY15";open "ARAY15",2;gto +2
62: open "ARAY15",2
63: asgn "ARAY15",1
64: sprt 1,N[*];sprt 1,Z[*],W[*];sprt 1,A[*],Q[*]
65: ret
66:
67: dsp "Program Finished"
68: end

```

"PLT15"

EQUIPMENT REQUIRED

1. Hewlett-Packard (HP) 9825B desktop computer
2. HP 9895/9885 flexible disk drive ROM
3. HP 9895 flexible disk drive
4. HP 9872A X-Y plotter

"PLT15"

PROGRAM LISTING

```

0: "This program is called PLT15; it plots analyzed data stored in the":
1: "data files created by HEAT15":
2: "Version: 16 February 1982 ** RPL ":
3:
4: dim C$(6),D$(80),E$(6),B$(3,80),N(3),F(15),M(12),P(5),A$(6)
5: dim F$(3,80),A(17),X(375),Y(375,17)
6: getk "KEY3"
7: dsp "Remove Program Disk";stp
8: dsp "Insert Data Disk";stp
9: ent "Enter name of analyzed data file",A$:prt "":prt A$:prt ""
10: ent "Plotter Select Code=?",P
11: asgn A$,1
12: sread 1,C$,D$,E$,3$,F$,N[*],r8
13: 0+A+C+T+J;100+D
14: ent "Number of Heat Flux sensors=?",Z
15: Z+2+V
16: ent "Max. time to be searched=?",B
17: dsp "SEARCHING FOR MAXIMUM VALUES"
18: on end 1,"THERE"
19:
20: "START":
21: sread 1,U,E,F[*],M[*],P[*]
22: if E>T;E+P;U+J
23: for K=1 to 15
24: if F(K)>A;F(K)+A
25: if F(K)<G;F(K)+G
26: next K
27: for K=1 to 12
28: if M(K)>C;M(K)+C
29: if M(K)<D;if M(K)>15;M(K)+D
30: next K
31: for K=1 to 5
32: if P(K)>C;P(K)+C

```

```

33: if P[K]<D;if P[K]>15:P[K]→D
34: next K
35: if T>=B;goto "THERE"
36: goto "START"
37:
38: "THERE":
39: fxd 2;rread 1,1
40: prt "# records=",J
41: prt "Max time=",T
42: prt "Max W/M^2=",A
43: prt "Min W/M^2=",G
44: prt "Max temp=",C
45: prt "Min temp=",D
46: prt ";";prt ""
47: psc P;pcldr;fxd 0
48: ent "Plot heat flux data?",r1
49: if r1=0;goto "TMP"
50: ent "Draw axes?",r1
51: if r1=0;sfg 1
52: ent "Maximum value of time=?",r10
53: ent "Maximum value of heat flux=?",r11
54: ent "Minimum value of heat flux=?",r15
55: if r1ql;goto +4
56: ent "X-axis tic interval=?",r12
57: ent "Y-axis tic interval=?",r13
58: pen# 1
59: r15-30+H;scl -5,r10,H,r11;if r1ql;goto +4
60: xax r15,r12,0,r10,1
61: yax 0,r13,r15,r11,1
62: lim 0,r10,r15,r11;goto "HERE"
63:
64: "HERE":
65: on end 1,"X"
66: ent "Plot individual sensors?",r1
67: if r1;0+r1;sfg 5
68: dsp "Heat Flux Data is being read"

```

```

69: sread 1,C$,D$,E$,3$,F$,N[*],r8
70: 0+Q
71: sread 1,U,E,F[*],M[*],P[*]
72: Q+1-Q;E-X[Q]
73: for S=1 to Z
74: F[S]->Y[Q,S]
75: if E>=8;goto "X"
76: next S
77: goto 71
78: "X":
79: fmt , "plotting sensor # ",f2.0
80: goto +3;if flg5;goto +1
81: ent "Sensor HF to be plotted?",S;goto +1
82: goto +2;if S>15;goto 94
83: for S=1 to Z
84: cll 'LINE'
85: wrt 0,S
86: plt X[1],Y[1,S],-2
87: for J=2 to Q
88: if X[J]>rl0;goto +3
89: plt X[J],Y[J,S],0
90: next J
91: pen
92: if flg5;goto 81
93: next S
94: pen# 0;plt rl0,rl1,1;fmt
95: cfg 5
96:
97: "T4":
98: ent "Plot individual temp sensors?",rl
99: if rl;0+rl;sfg 5
100: if flg5;goto +3
101: ent "Do you want to delete some 'T4P?',rl
102: if rl;0+rl;cll 'DEL'
103: line ;sfg 2
104: dsp "prepare plotter for TEMP plot";stp

```

```

105: fxd 1;cfg 1
106: ent "Draw axes?",r1
107: if r1=0;sfg 1
108: ent "Maximum value of time=?",r10
109: ent "Maximum value of temperature=?",r11
110: ent "Minimum value of temperature=?",r15
111: if r1g1;gto +4
112: ent "X-axis tic interval=?",r12
113: ent "Y-axis tic interval=?",r13
114: pen# 1
115: r15-.5+E;sc1 -5,r10,E,r11;if flg1;gto +4
116: lim ;fxd 0;xx r15,r12,0,r10,1
117: yax 0,r13,r15,r11,1
118: lim 0,r10,r15,r11
119:
120: "NEXT":
121: rread 1,1
122: on end 1,"Y"
123: dsp "Temperature Data is being read"
124: sread 1,C$,D$,E$,B$,F$,N[*],r8
125: 0-Q
126: sread 1,U,E,F[*],M[*],P[*]
127: 1+Q+Q;E+X[Q]
128: for S=1 to V
129: if S<13;M[S]+Y[Q,3]
130: if S>12;P[S-12]+Y[Q,S]
131: if E>=3;gto "Y"
132: next S
133: gto 126
134: "Y":
135: fmt , "Plotting sensor # ",F2.0
136: gto +3;if flg5;gto +1
137: ent "MAP sensor to be plotted=?",S
138: gto +2;if S>17;gto 151
139: for S=1 to V
140: wrt 0,3

```

```

141: cll 'LINE'
142: if A[S]=1;goto +8
143: plt X[1],Y[1,S],-2
144: for J=2 to Q
145: if X[J]>rl0;goto +3
146: plt X[J],Y[J,S],0
147: next J
148: pen
149: if flg5;goto 137
150: next S
151: pen# 0;plt rl0,rl1,1
152: cfg 5
153: ent "Another set of plots to be run?",rl
154: if rl=1;goto 9
155: dsp "PLOTING ROUTINE FINISHED"
156: end
157:
158: "LINE":
159: if flg2 and S>10;goto "1"
160: if S<5;pen# 1
161: if S>4 and S<9;pen# 2
162: if S>3 and S<13;pen# 3
163: if S>12;pen# 4
164: if S=1 or S=5;line
165: if S=9 or S=13;line
166: if S=2 or S=6;line 3,2
167: if S=10 or S=14;line 3,2
168: if S=3 or S=7;line 5
169: if S=11 or S=15;line 5
170: if S=4 or S=8;line 6
171: if S=12 or S=16;line 6
172: if S=17;line 3,2
173: ret
174:
175: "T":
176: if S=13 or S=14;pen# 3

```

```

177: if S=11 or S=12;pen# 4
178: if S>14;pen# 4
179: if S=11 or S=13;line 5
180: if S=12 or S=14;line 6
181: if S=15;line
182: if S=16;line 3,2
183: if S=17;line 5
184: ret
185:
186: "DEL":
1 /: ent "How many TMPs to be deleted?",F
188: for I=1 to F
189: ent "TMP sensor # to be deleted="?,W
190: I-A(W)
191: next I
192: ret

```

HFS#	TMP#	PLOTTER PEN#	PLOTTER LINE PATTERN
1	1	1	_____
2	2	1	_____
3	3	1	_____
4	4	1	_____
5	5	2	_____
6	6	2	_____
7	7	2	_____
8	8	2	_____
9	9	3	_____
10	10	3	_____
-	11 (RECTAL)	4	_____
-	12 (AMBIENT)	4	_____
AUX1	AUX1	3	_____
AUX2	AUX2	3	_____
AUX3	AUX3	4	_____
AUX4	AUX4	4	_____
AUX5	AUX5	4	_____

"AVG15"

EQUIPMENT REQUIRED

1. Hewlett-Packard 9825B desktop computer
or
Hewlett-Packard 9825A with the followings ROM's:
 - a. general I/O
 - b. extended I/O
 - c. advanced programming
 - d. string variable
2. HP 98034A (HP-IB) interface bus
3. HP 9895/9885 flexible disk ROM
4. HP 9895 flexible disk drive
5. Printer for computer such as HP 9866, HP 9876, HP 7245

"AVGL5"

PROGRAM LISTING

```

0: "This program is called AVGL5; it takes data created by HEAT15 and ":
1: "its various modified versions and produces averaged values over a ":
2: "period chosen by the user":
3: "Version: 16 February 1982 ** RPL ":
4:
5: dim C$(6),D$(80),E$(6),B$(3,80),F$(3,80),N(3),F(15),M(12),P(5)
6: dim A$(6),A(2),H(17),T(17),N$(17,10),U(2),D(17)
7: getk "KEYS"
8: dsp "Remove Program Disk";stp
9: dsp "Insert Data Disk in drive 0";stp
10: ent "Printer Select Code=?",N;if N=706 or N=606;wtb N,27,40,65
11: ent "Enter name of analyzed data file",A$
12: asgn A$,1
13: sread 1,C$,D$,E$,B$,F$,N[*],r8
14: ent "Do you want max time search?",r1;if r1=0;goto 23
15: on end 1,"ONE"
16: dsp "Finding maximum time"
17: sread 1,U,E,F[*],M[*],P[*]
18: goto -1
19: "ONE":
20: prt "Max record # =",U
21: prt "Max time=",E
22: prt " ";prt " ";prt " "
23: cll 'SITE'
24: rread 1,1
25: sread 1,C$,D$,E$,B$,F$,N[*],r8
26: cll 'AVG'
27: cll 'PRINT'
28: ent "Average another period?",r1
29: if r1;goto 26
30: ent "Analyze another data file?",r1
31: if r1;goto 11
32: end

```

```

33: "AVG":
34: ent "# of first record wanted?",A[1]
35: ent "# of last record wanted?",A[2]
36: dsp "Averaging data"
37: l+A[2]-A[1]→A
38: for I=1 to 17;0→H[I]→T[I];next I
39: sread 1,U,E,F[*],M[*],P[*]
40: if U<A[1]-1;goto -1
41: if U=A[1];sfg 3
42: for J=A[1] to A[2]
43: if flq3;cfg 3;goto +2
44: sread 1,U,E,F[*],M[*],P[*]
45: if J=A[1];E→U[1]
46: if J=A[2];E→U[2]
47: for I=1 to 15
48: H[I]+F[I]→H[I]
49: next I
50: for I=1 to 10
51: T[I]+M[I]→T[I];D[I]+M[I]-M[12]→D[I]
52: next I
53: for I=1 to 5
54: T[I+10]+P[I]→T[I+10];D[I+10]+P[I]-M[12]→D[I+10]
55: next I
56: for I=1 to 2
57: T[I+15]+M[10+I]→T[I+15];D[I+15]+M[10+I]-M[12]→D[I+15]
58: next I
59: next J
60: for I=1 to 17
61: H[I]/A→H[I];T[I]/A→F[I];D[I]/A→D[I]
62: next I
63: ret
64:
65: "SITE":
66: ent "Create new SITE file?",rl
67: if rl#1;goto +3

```

```

69: cll 'ENTER'
70: cll 'CREATE'
71: asgn "SITE",2
72: sread 2,N$
73: ent "Do you want SITE printed?",rl
74: if rl#1;goto +6
75: fmt 3,f2.0,5x,c10
76: for i=1 to 17
77: .3+N+G;wrt G,I,N${I}
78: next i
79: fmt ,3/,wrtN;fmt
80: ent "Do you want to change SITE?",rl
81: if rl=0;goto +4
82: cll 'ENTER'
83: cll 'CREATE'
84: goto 73
85: ret
86:
87: "ENTER":
88: fmt , "SENSOR #",f2.0
89: for i=1 to 15
90: wrt 0,i;stp
91: ent "Body site name=?",N${I}
92: next i
93: "RECTAL"→N${16};"ENVIRON"→N${17}
94: ret
95:
96: "CREATE":
97: ent "Does previous SITE file exist?",rl
98: if rl;kill "SITE";open "SITE",2;goto +2
99: open "SITE",2
100: asgn "SITE",2
101: sprt 2,N$
102: ret
103:
104: "PRINT":

```

```

105: wtb N,27,38,107,48,83;fmt
106: fmt ,6;/wrt N;fmt
107: wrt N,"Name of analyzed data file: ",A$
108: wrt N;wrt N,"Header of analyzed data file: "
109: for I=1 to 3;wrt N,F$(I);next I
110: fmt 5,2/,"Calibration file name: ",C6;N+.5+r2;wrt r2,C$
111: wrt N;wrt N,"Original data file name: ",E$;wrt N
112: wrt N,"Header of original data file: "
113: for I=1 to 3;wrt N,B$(I);next I
114: wrt N
115: fmt 1,"DATA AVERAGED FROM RECORD # ",f3.0," TO RECORD # ",f3.0,/
116: N+.1+r2
117: wrt r2,A[1],A[2]
118: fmt 1,"Time at first record= ",f6.2," Time at last record= ",f6.2,4/
119: wrt r2,U[1],U[2]
120: wtb N,27,38,107,49,83
121: fmt 1,10x,"REGIONAL HEAT FLUX",2;/wrt r2
122: fmt 1,"HFS",3x,"W/M^2",3x,"deg. C",3x,"dt",5x,"h",4x,"BODY SITE",2/
123: wrt r2
124: fmt 2,f2.0,3x,f7.2,3x,f5.2,x,f5.2,2x,f5.1,x,c10,/
125: N+.2+r2
126: for I=1 to 17
127: if D[I]#0;H[I]/D[I]+B
128: if D[I]=0;0+B
129: wrt r2,I,H[I],F[I],D[I],B,N$(I)
130: next I
131: wtb N,27,38,107,48,83
132: wtb N,27,85
133: ret

```

"AVG15"

VARIABLE LISTING

A	Number of records averaged
B	temporary storage for convective heat transfer coefficient
E	time of data in minutes
I	counter
J	counter
N	printer select code
U	record number of data
A[*]:	period to be averaged
A[1]	first period to be included in average
A[2]	last period to be included in average
D[*]	D[I] is average value of [(temperature # I) - (ambient temperature)]
F[*]	F[I] is scaled heat flux for sensor # I for current record
H[*]	H[I] is average heat flux for sensor # I
M[*]	M[I] is scaled temperature for multiplexed sensor for current record
N[*]	number of sensors as recorded on data file
P[*]	P[I] is scaled temperature for auxiliary sensor for current record
T[*]	T[I] is average temperature for sensor # I
U[*]:	max and min times
U[1]	time corresponding to period A[1]
U[2]	time corresponding to period A[2]
A\$	name of analyzed data file
B\$	header of original data file
C\$	name of original calibration file
D\$	used
E\$	name of original data file
F\$	header of analyzed data file
N\$	"SITE" file names
	N\$[I], $1 \leq I \leq 10$, multiplexed sensor # I
	N\$[I], $11 \leq I \leq 15$, auxiliary sensor # (I-10)
	N\$[16], "RECTAL," rectal temperature
	N\$[17], "ENVIRON," environmental temperature

UTILITY PROGRAMS

"RCAL15" PROGRAM LISTING

```

0: "Program name: RCAL15":
1: "This program reads numbers from disk Calibration file and prints them":
2: "This program is to be used with data obtained with program FLUX15 only":
3: "Version: 1 February, 1982 ** RPL ":
4:
5: dim X[4,15],Y[2,5],C$[6],D$[80],D[2,5]
6: dsp "Remove Program Disk";stp
7: dsp "Insert Data Disk";stp
8: ent "Enter name of file to be read",C$
9: asgn C$,1
10: sread 1,D$
11: sread 1,r2,r3,r4,r5,r6,r7
12: sread 1,X[*]
13: sread 1,Y[*]
14: sread 1,D[*]
15: on end 1,"TIME"
16: fmt 1,/, "HFS calibration input voltages (mv)",/,f10.6,5x,f10.6,2/
17: wrt 706.1,r2,r3
18: fmt 2,f2.0,5x,f10.6,5x,f10.6
19: for i=1 to 10
20: wrt 706.2,i,X[1,i],X[2,i]
21: next i
22: wrt 706;wrt 706,"AUXILIARY HFS"
23: for i=1 to 5
24: wrt 706.2,i,Y[1,i],Y[2,i]
25: next i
26: fmt 3,/, "Temperature calibration input values",/,f6.2,5x,f6.2,2/
27: wrt 706.3,r6,r7
28: for i=1 to 12
29: wrt 706.2,i,X[3,i],X[4,i]
30: next i
31: wrt 706;wrt 706,"AUXILIARY TEMPERATURE SENSORS"
32: for i=1 to 5

```

33: wrt 706.2,I,D[1,I],D[2,I]
34: next I
35: "TIME":
36: stp
37: end

UTILITY PROGRAMS

"RDAT15" PROGRAM LISTING

```

0: "Program name: RDAT15":
1: "This program reads numbers from the disk data file and prints them":
2: "This program will read data obtained using program FLUX15 only":
3: "Version: 25 February 1982 ** RPL ":
4:
5: dim H[15],A[5],T[15],B[5]
6: getk "KEYS"
7: dim A$(6),B$(3,80)
8: dsp "Remove Program Disk";stp
9: dsp "Insert Data Disk";stp
10: ent "Enter name of file to be read",A$
11: asgn A$,1
12: ent "Do you want Temperature values?",r1
13: for i=1 to 3
14: sread 1,B$(i)
15: wrt 706,B$(i)
16: next i
17: sread 1,H,L;wrt 706;wrt 706,H,L
18: sread 1,U,E,H[*],A[*],T[*],B[*],C,D,F
19: wrt 706,U,E;wrt 706
20: fmt 1,f7.3,z
21: for i=1 to 10
22: wrt 706.1,H[i]
23: next i
24: wrt 706
25: if r1=0;goto 31
26: fmt 1,f7.2,z
27: for i=1 to 12
28: wrt 706.1,T[i]
29: next i
30: wrt 706
31: for i=1 to 5;wrt 706.1,A[i];next i
32: wrt 706

```

AD-A122 567

DATA ACQUISITION AND ANALYSIS SOFTWARE FOR THERMAL
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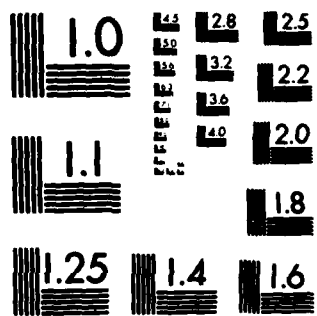
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
33:  for I=1 to 5;wrt 706.1,B[I];next I
34:  wrt 706
35:  on end 1,"TIME"
36:  gto 18
37:  "TIME":
38:  stop
39:  end
```

UTILITY PROGRAMS

"cmbDAT" PROGRAM LISTING

```

0: "This program is called cmbDAT; it combines 2 data files analyzed by":
1: "HEAR15 into a single analyzed data file. It ":
2: "provides for adding time to the clock time in the second file, which ":
3: "is useful when time has elapsed between the end of the first data file":
4: "and the start of the second one. The program uses the 9895 dual disk":
5: "drive. The disk with the original data must be in drive0, the disk ":
6: "for the new combined file must be in drive1. The combined file is ":
7: "stored under the name given on disk in drive1":
8: "version : 26 February 1982 ** RPL ":
9:
10: dim C$[6],D$[80],E$[6],B$[3,80],N[3],F[15],M[12],P[5],F$[3,80]
11: dim R$[6],S$[6],Q$[3,80],A$[6]
12: dsp "Remove Program Disk";stp
13: dsp "Insert Data Disk in drive 0";stp
14: dsp "Insert new file disk in drive 1";stp
15: ent "Name of first data file?",R$
16: ent "Name of second data file?",S$
17: ent "Name of combined data file?",A$
18: asgn R$,1,0
19: asgn S$,2,0
20: ent "# of records for combined file?",X
21: drive 1
22: open A$,X
23: drive 0
24: asgn A$,3,1
25: sread 1,C$,D$,E$,B$,F$,N[*],r8
26: for I=1 to 3
27: ent "New header for combined file?",Q$[I]
28: next I
29: ent "Elapsed minutes between files=?",Y
30: sprt 3,C$,D$,E$,B$,Q$,N[*],r8
31: on end 1,"ONE"
32: dsp "Combining Data Files Now."

```

```

33: sread 1,U,E,F[*],M[*],P[*]
34: sprt 3,U,E,F[*],M[*],P[*]
35: gto -2
36: "ONE":
37: Y+E+Y
38: sread 2,C$,D$,E$,B$,F$,N[*],r8
39: on end 2,"END"
40: sread 2,U,E,F[*],M[*],P[*]
41: E+Y+E
42: sprt 3,U,E,F[*],M[*],P[*]
43: gto -3
44: "END":
45: dsp "Finished"
46: end

```

UTILITY PROGRAMS

"negHFS" PROGRAM LISTING

```

0: "This program is called negHFS; it reverses the polarity of heat flux":
1: "for a given sensor in an analyzed data file created by HEAT15 or one":
2: "of its various versions.":
3: "Version: 26 February 1982 ** RPL":
4:
5: dim A$(6),C$(6),D$(80),E$(80),B$(3,80),F$(3,80),N(3),F(15),M(12),P(5)
6: dim W(15)
7: dsp "Remove Program Disk";stp
8: dsp "Insert Data Disk in drive 0";stp
9: dsp "Insert Scratch Disk in drive 1";stp
10: ent "Name of Data file?",A$
11: asgn A$,1,0
12: sread 1,C$,D$,E$,B$,F$,N[*],r8
13: for I=1 to 3;prt F$(I);next I
14: ent "Number of records in data file?",A
15: drive 1
16: open "TEST",A
17: asgn "TEST",2,1
18: drive 0
19: sprt 2,C$,D$,E$,B$,F$,N[*],r8
20: ent "How many HFS to be reversed?",C
21: for I=1 to C
22: ent "HF sensor # to be reversed=?",B
23: l-W(B)
24: next I
25: on end 1,"END"
26: dsp "Program is running now"
27: "ONE":
28: sread 1,U,E,F[*],M[*],P[*]
29: for I=1 to 15
30: if W(I)=1;-F(I)->F(I)
31: next I
32: sprt 2,U,E,F[*],M[*],P[*]

```

33: gto "ONE"
34: "END":
35: drive 0
36: kill A\$
37: copy "TEST",1,707,A\$,0,707
38: drive 1
39: kill "TEST"
40: drive 0
41: dsp "Finished"
42: end

